POWER

Volume 58 New York, July 3, 1923 *Number* 1

Weight

A READER, out in Arizona, asks me to write about weight. The dictionary says that weight is the effect of gravity. If this is so, a pound weight is different in different parts of the earth, for the force of gravity varies inversely as the square of the distance from the earth's center and is counteracted to some extent by the centrifugal force due to the earth's rotation.

In the Bureau of Standards at Washington is a cylinder of metal which is our standard pound. If this is put into one pan of a beam scale and enough of some other material is put into the other pan to balance it, that material will "weigh" a pound. There is a pound of mass or of matter in each pan, and it will be a pound whether the weighing is done at the equator or at the pole, on top of the highest mountain or at the bottom of the deepest mine.

But hang the standard weight onto a spring scale and the indication will vary with latitude and with altitude. At the equator the centrifugal force tends to throw the weight away from the earth and lightens its pull upon the spring. At the poles there is no such centrifugal force and the weight, as measured by the tension that it puts upon the spring, would be more.

Neither of these things affects it very much. The total variation in going from the equator to the pole would be only about 0.005 of a pound, and the weight, would be only about 0.000095 of a pound less for each 1,000 feet above sea level.

But in the interest of precision and clear thinking and in the finer work of the physicist, it is necessary to distinguish between the pound of mass and the pound of force. The pound of mass is the mass that will balance the standard pound weight on a beam scale and is the same the world over. We ought to think and talk of it as mass instead of weight. The pound of force—and the spring scale measures not the mass, but the force or weight with which it pulls upon the sprin —is, by general agreement, taken as that force which is exerted by gravity between the earth and a pound of mass at latitude 45 degrees and at sea level.

F. R. Low

Northeast Station Kansas City, Mo., Adds 30,000 Kilowatts

By THOMAS WILSON

BOILERS of latest design supplying steam at the temperature of 650 deg. F., are equipped with forced-draft chain grates and high-pressure counterflow economizers, and provision has been made for plate-type air preheaters. Other salient features are submerged ashpits, great flexibility in coal handling, and provision for rapid transfer to oil fuel.

INDUSTRIALLY, Kansas City, Mo., has been growing in importance. New concerns are locating and established companies expanding so that the commercial power load is increasing steadily and to such an extent recently as to necessitate a 30,000-kw. addition to the new Northeast Station of the Kansas City Power & Light Co. From a previous description of the initial plant, appearing in the issue of Sept. 21, 1920, it will be recalled that the original plans were for a station containing four unit groups with a condenser well for each and two intake wells for the four. The first group unit, with its complement of eight boilers comprising the initial installation, contains three 20,000-kw. machines over a single condenser well. Each of the other three condenser wells will serve two turbo-generators rated individually at 30,000 kw., but with a maximum capacity of 35,000 kw., so that the station, as planned, will have an aggregate capacity of 270,000 kilowatts.

The present addition is the first machine of the second unit group and its complement of four boilers. From the plan view, Fig. 2, it is obvious that the building has been completed for the companion turbo-generator and four more boilers. A new mine-mouth plant to be located at Glasgow, some 110 miles distant, is also contemplated.

In the initial installation the outstanding features were a special arrangement of high- and low-pressure economizers, induced-draft chain-grate stokers 17.5 ft. long, submerged ashpits, vertical condensers placed in a well to meet the great changes in river level, and a number of features new at that time on the electrical side.

In the present addition the layout has been made along the same general lines, although, through the ingenuity of Edwin Jowett, superintendent of production, and his staff of station engineers, a number of innovations have been incorporated. The coal-handling system has been remodeled completely, the economizers are of the high-pressure counterflow type, provision has been made for the installation of air preheaters of the plate type back of the economizers, and the stokers are

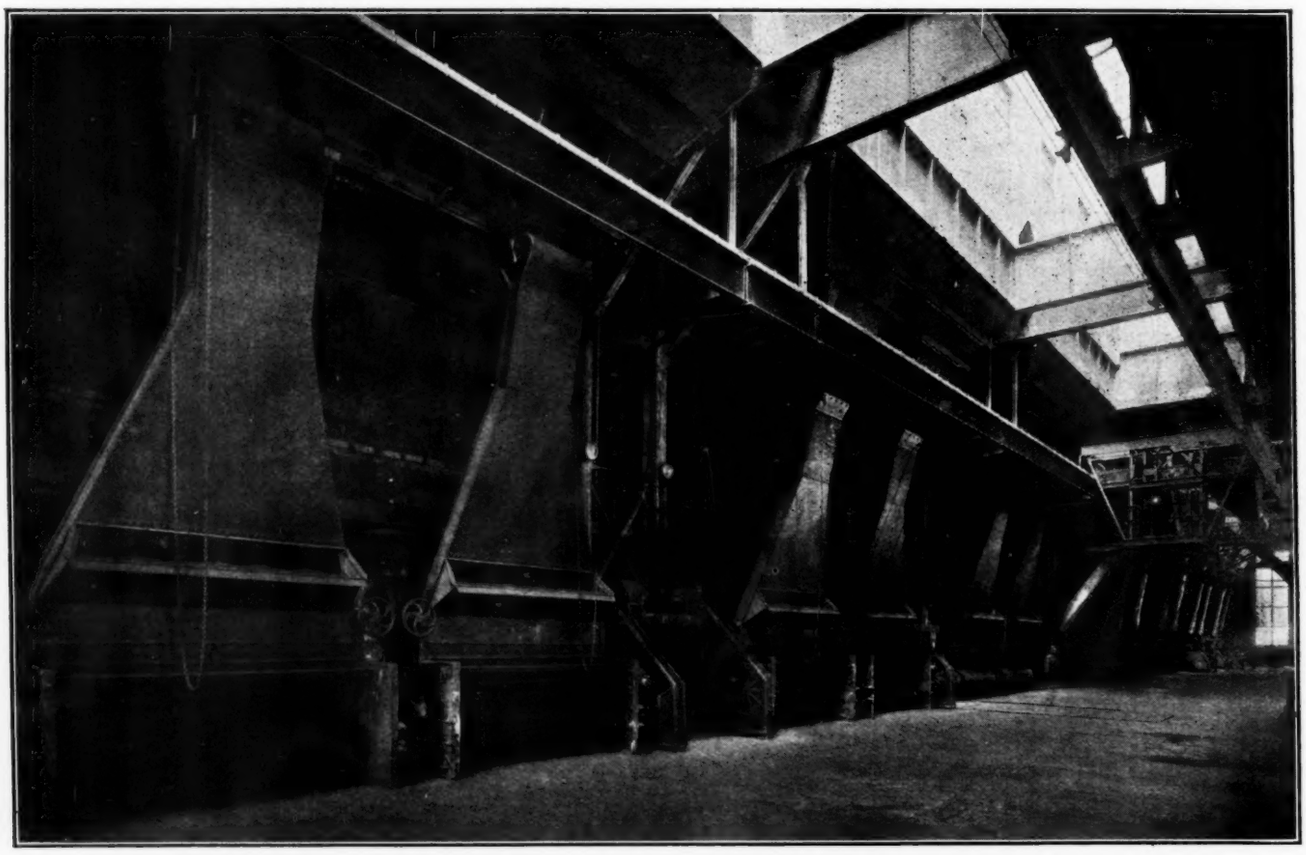


FIG. 1—BOILER ROOM OF NORTHEAST STATION; NEW BOILERS IN FOREGROUND

forced-draft chain grates. The forced-draft fans are placed high up at the economizer level to be in near proximity to the induced-draft fans and also to the air preheaters. Double- and triple-decked boilers of the latest design are installed. The larger valves are under hydraulic control. Oil is used as the operating medium, the pressure being maintained by an accumulator in conjunction with a motor-driven power pump drawing current from the storage battery. All valves and fittings, even down to the ¾-in. size, are flanged. A house turbine is part of the new equipment, and provision

In the addition to the boiler room at the left are the four new boilers, and on the opposite side of the firing aisle is space for the four additional boilers that will be needed when the next 30,000-kw. machine is installed. The boilers operate under the same working conditions as their predecessors; that is, while designed for an operating pressure of 300 lb. gage, the pressure carried ranges from 275 to 280 lb., and the superheat approximates 250 deg. F., giving a final steam temperature in the vicinity of 650 deg. F.

Containing 12,743 sq.ft. of steam-making surface, the

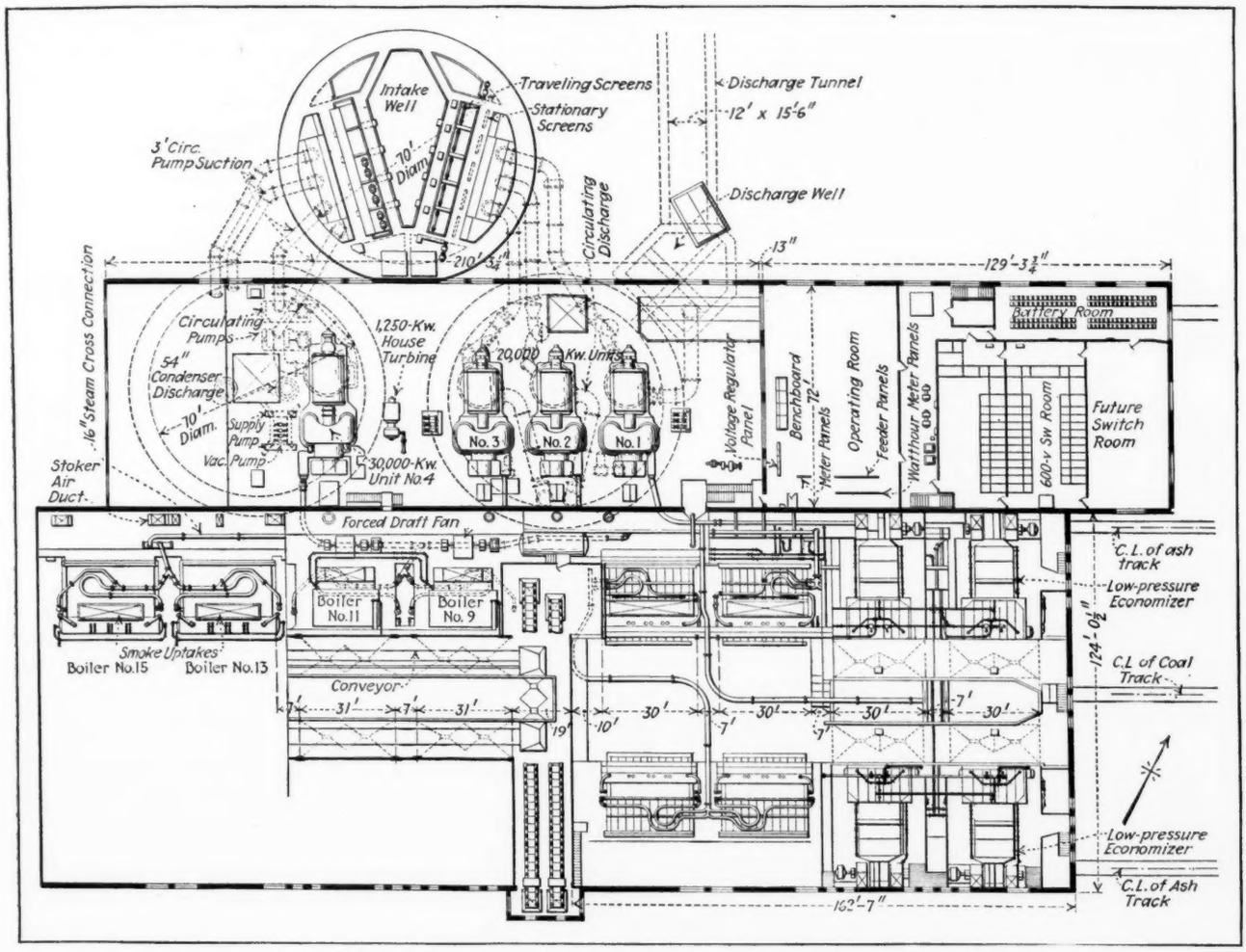


FIG. 2—PLAN OF STATION AS COMPLETED TO DATE

has been made to bleed steam from the new generating unit to maintain the heat balance. The features enumerated and others to be brought out later all contribute toward making the station one of the most modern of its kind in the country.

Reference to the plan view, Fig. 2, will show the general arrangement. At the right are the eight boilers of the initial plant, installed four on either side of a central firing aisle. Each of these boilers, which are of the cross-drum type, contains 13,512 sq.ft. of steam-making surface and an active grate area of 350 sq.ft. in two stokers per boiler, giving a ratio of grate area to boiler-heating surface of 1 to 38.6 and a provision of 8.9 cu.ft. of furnace volume per square foot of active grate. Burning the inferior coals of the surrounding states required a grate of relatively large proportions.

new boilers are slightly smaller than the older ones. Two of them are the first of the new Heine "S" type to be installed. Notable features of these boilers are sectional headers and a division of the heating surface into three banks. The lower deck, containing the first two rows of tubes, is exposed for its full length to the radiant heat from the fire. To facilitate cleaning and tube removal, the remaining surface is divided into two banks, each six tubes high, as indicated in Fig. 3. Cast-steel headers of serpentine outline each serve two vertical rows of tubes. Horizontally, the tubes of each header are in line and are staggered with the pairs of tubes in the adjacent headers. The tube spacing is such as to provide straight diagonal lanes throughout the boiler for facilitating cleaning. Tubes of 3½ in. diameter are used and ample space allowed between

them for rodding. A sloping baffle has been so placed as to give exceptionally large area for the entrance of the gases into the first pass and to reduce the cross-section of the gas passage to correspond with the shrinkage in volume.

The other two boilers, which contain the same amount of steam-making surface, are of the B. & W. cross-drum Cheswick type in which the heating surface has been divided into an upper and lower deck separated to give

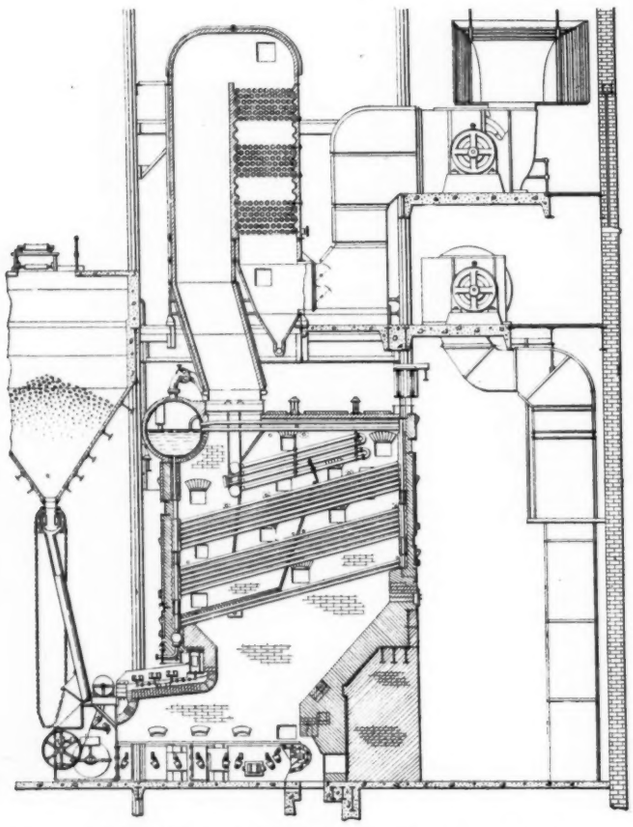


FIG. 3—SECTIONAL ELEVATION THROUGH NEW TYPE S HEINE BOILER AND FOSTER ECONOMIZER

a space for the superheater nearer the furnace, as shown in Fig. 4. This arrangement, with about one-third of the steam-generating surface in the lower deck, gives maximum utilization of the radiant heat and an increase in the proportion of heating surface subjected to the highest gas temperatures. Doubling the area of gas exit from the furnace lowers the velocity of the gases and tends to reduce slag accumulation on the lower tubes. In its new location—namely, four tubes up—the superheater requires less surface.

From all boilers the uptakes rise to the tops of the economizers, which are of the transverse counterflow design, in which the gases make a single pass downward through the economizer and then up through the air heater or connecting flue, as the case may be, into the induced-draft fan and out to the stack. The feed water enters at the bottom of the economizer, traveling backward and forward through the tubes to the exit at the top. The Duratex economizers serving the B. & W. boilers each contain 6,250 sq.ft. of surface. They are compactly arranged, being high and narrow, so that there is plenty of room above the boiler for a plate-type air preheater between the economizer and the forced-draft and induced-draft fans. Only one of these air preheaters has been installed, but if it proves successful all four boilers will be equipped, provision having been made for their installation even to the point of locating on the economizer floor the motor-driven forced-draft fans, which are provided with extension shafts to give space for the air ducts from the preheaters. The air from the top of the building will be drawn down through the air heater into the forced-draft fans and by them be pushed downward to the stokers.

As shown in the sectional views through these boilers, the induced-draft fans have been located back of the economizers. There is one fan to each boiler and two boilers per stack, the latter being of the self-supporting steel type, 10 ft. in diameter and rising 50 ft. above the roof. As the gases discharge to atmosphere at temperatures of 260 to 300 deg., depending upon the rate of operation, the stacks are unlined.

Economizers for the two Heine boilers are of the new Foster high-pressure type made up of straight steel tubes entirely inclosed by a series of cast-iron gilled rings. These rings protect the steel piping from the gases and increase the surface exposed, which in the present case amounts to 8,100 sq.ft., or about two-thirds of the steam-making surface in the boiler. One of the economizers is equipped for the new water method of washing and the other with steam jets to remove soot.

For both types of boiler the furnace design is practically identical. A sloping rear wall has been employed, with inspection doors at the grate level and sliding doors just below the tubes, through which slag accumulations may be removed, preferably during banking hours, but if necessary, when the boiler is in operation. The volume approximates 5,000 cu.ft., which reduces to 14.7 cu.ft. per square foot of grate. Radial-end fire arches of both single- and double-suspension types have been employed, and in either case they extend across the full width of the furnace, a distance of 24 ft. 10 in. In one case I-beams, making the full span, support the arch, and in the other a cross-beam at the center divides the span, so that channels running either way to the side walls are the supporting members.

With a wide variety of fuel, ranging from typical Arkansas anthracite and semi-anthracite from Oklahoma to the low-grade bituminous coals from Iowa, it was decided to install forced-draft chain grates. Stokers of two different makes were selected, one employing six zones and the other eight, and all driven individually by belted direct-current motors. As in the initial part of the station, two stokers are used per boiler, with a low center wall between them rising slightly above the grate level. The stokers are approximately 10½ ft. wide by 15½ ft. long, with an effective aggregate area per boiler of 340 sq.ft. which to the steam-making surface bears a ratio of 1 to 38.

To prevent clinker adhesion, ventilated tile are used along the side and center walls at the grate level. This construction was preferred to the use of water boxes at the sides, and even at the rear the usual water-back has been omitted. Protection to the grate at the turn from reflected heat is effected by an overhanging bridge wall with renewable tile suspended at the heel.

Each boiler has its individual forced-draft fan which, however, is cross-connected with the fans of the other units, so that any pair of stokers may draw their air supply either from their individual fan or from the main duct. The air enters the stokers from either side through supply ducts in the side walls and a central duct between the stokers.

Over the central duct under one boiler an innovation has been made in the form of a cast-iron box through which a portion of the air passes and is introduced into the first two zones to improve the ignition of the anthracite and low grades of bituminous coal burned in the plant. The interior of the box is cast in the form of radiating fins to increase the surface, and on the outside the box has been so shaped as to support protecting tile.

The location of the fans on the economizer floor above the boilers is unusual, but it was considered desirable to place them near the air preheaters through which they may eventually draw their supply, and with both forced- and induced-draft fans in near proximity, one attendant can take care of both.

One of the outstanding features of the station is the method of discharging the ash from the rear of the stokers down through shafts into a series of water-filled pits the tops of which are 30 ft. below. From the pits the ashes are removed by a clamshell bucket operating from a traveling crane spanning the ash track serving its respective row of boilers. Full details of this system appeared in the April 4, 1922, issue of *Power*.

In a station isolated from other sources of generation and depending entirely upon its own resources, continuity of the coal supply to the boilers is a factor of decided importance. From this viewpoint a continuation of the original system of coal handling was open to objection, as it did not offer sufficient protection. The failure of one conveyor might shut down the boilers on one side of the firing aisle, as there was no ready means of transferring coal from one side to the other.

Careful consideration led to remodeling, from designs of Mr. Jowett, the coal handling into a system offering protection against interruption of the supply to an unusual degree and affording the utmost flexibility. At the same time it was decided to do most of the unloading of coal outside the station, as with the original storage pit under the central firing aisle, there was always the possibility of coal dust finding its way up through the station.

Reference to the previous article will show that a concrete coal-storage pit had been placed under the central firing aisle of the boilers with a coal track at grade running over the center of the pit. A traveling crane with a grab bucket transferred the coal to traveling coal crushers on either side, which delivered to continuous bucket conveyors making a lengthwise circuit of the boiler room over the individual bunkers.

These bucket conveyors were removed to a transverse section of the boiler house between the new and the older construction. Arranged perpendicularly to the firing aisle, either one of the two conveyors may now deliver onto any one of four belt conveyors, two of which travel into the older part of the boiler room to fill the bunkers on either side of the firing aisle and the other two perform the same service in the new section. The second belt conveyor in the new section is to be placed with the installation of the next unit. As practically all coal used at the station is prepared at the mine, no change has been made in the coal-crushing arrangements. Whatever crushing may be necessary is done with a 4-roll crusher over the belt feeding the pivoted bucket carriers on the bottom run.

Reference to Figs. 2 and 5 will show the arrangement. Hoppers on either side of the firing aisle receive the coal from the pivoted bucket carriers and deliver it to the belt conveyors. Immediately over the firing aisle a third hopper has been interposed for the purpose of receiving coal from the pivoted bucket carriers and storing it in case of need. This hopper, or central bunker, has two outlet gates through which the coal may be delivered into weigh hoppers, one on either side of a weigh larry traveling the full length of the boiler

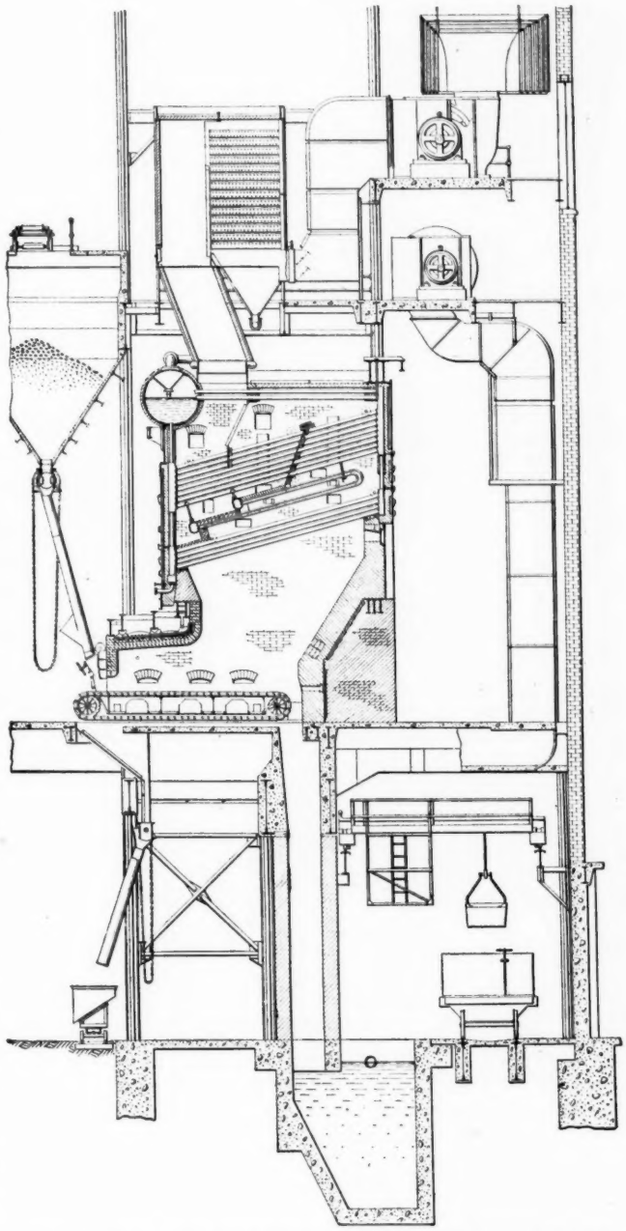


FIG. 4—SECTION THROUGH B. & W. CHESWICK TYPE BOILER AND DURATEX ECONOMIZER

room. Delivery may be made to any stoker in either row through an extended lip near the bottom of the coal chute ordinarily serving the stoker. This unusual construction is shown plainly in Fig. 1.

The advantages of this unique arrangement of equipment are fourfold: First, in the event of a broken bunker belt, coal from the central hopper may be delivered to any one or all four of the boilers served; secondly, on any individual boiler or group of boilers, under peak-load conditions, the coal suddenly may run below the average and an immediate change may be made to the good grade of coal usually maintained in

the central bunker; thirdly, an individual boiler may be tested without interfering with routine operation merely by closing off its bunker gate and taking coal from the central bunker through the weigh larry; fourthly, the larry is also provided with an electric hoist for handling any heavy material in the main firing aisle or from cars below the boiler-room floor.

Although the coal-storage pit below the firing aisle has not been extended into the new part of the boiler room, it is still retained to unload coal for immediate use. On one side a belt conveyor has replaced the old equipment and delivers to either one or both of the continuous bucket conveyors. On the other side an industrial car receives the siftings from the stokers, which are reclaimed by being dumped into the continuous conveyors. In case the belt conveyor over the storage pit should fail, delivery to the coal-handling system may be made from one of the ash tracks, by spotting the car at the center of the boiler room, opposite a hopper arranged to deliver into either one of the continuous conveyors, the ash crane with its 1½-cu.yd. bucket making the transfer from car to hopper.

In the past coal has been transferred from railway cars into yard storage and vice versa by locomotive cranes. At the present writing there is under construction a system that will make it possible to unload all coal, both for immediate use and storage, outside the building, without utilizing the unloading equipment provided within the plant. Two parallel coal tracks 300 ft. long are to be laid on a concrete structure rising 20 ft. above the ground level to be above the flood waters of the Missouri. Between the tracks will be a 36-in. conveyor belt running the full length of the structure. A locomotive crane will transfer the coal from the cars to the belt through a traveling loading hopper, and delivery will be made into a receiving hopper at the end of the elevation. From the hopper an apron feeder will transfer the coal to a cross-belt delivering onto one or both of the continuous bucket conveyors in the plant.

From both of the elevated tracks storage coal to the amount of 30,000 tons will be within reach of the locomotive crane. Farther out in the yard there is space for an additional 30,000 tons, but as in the past, the

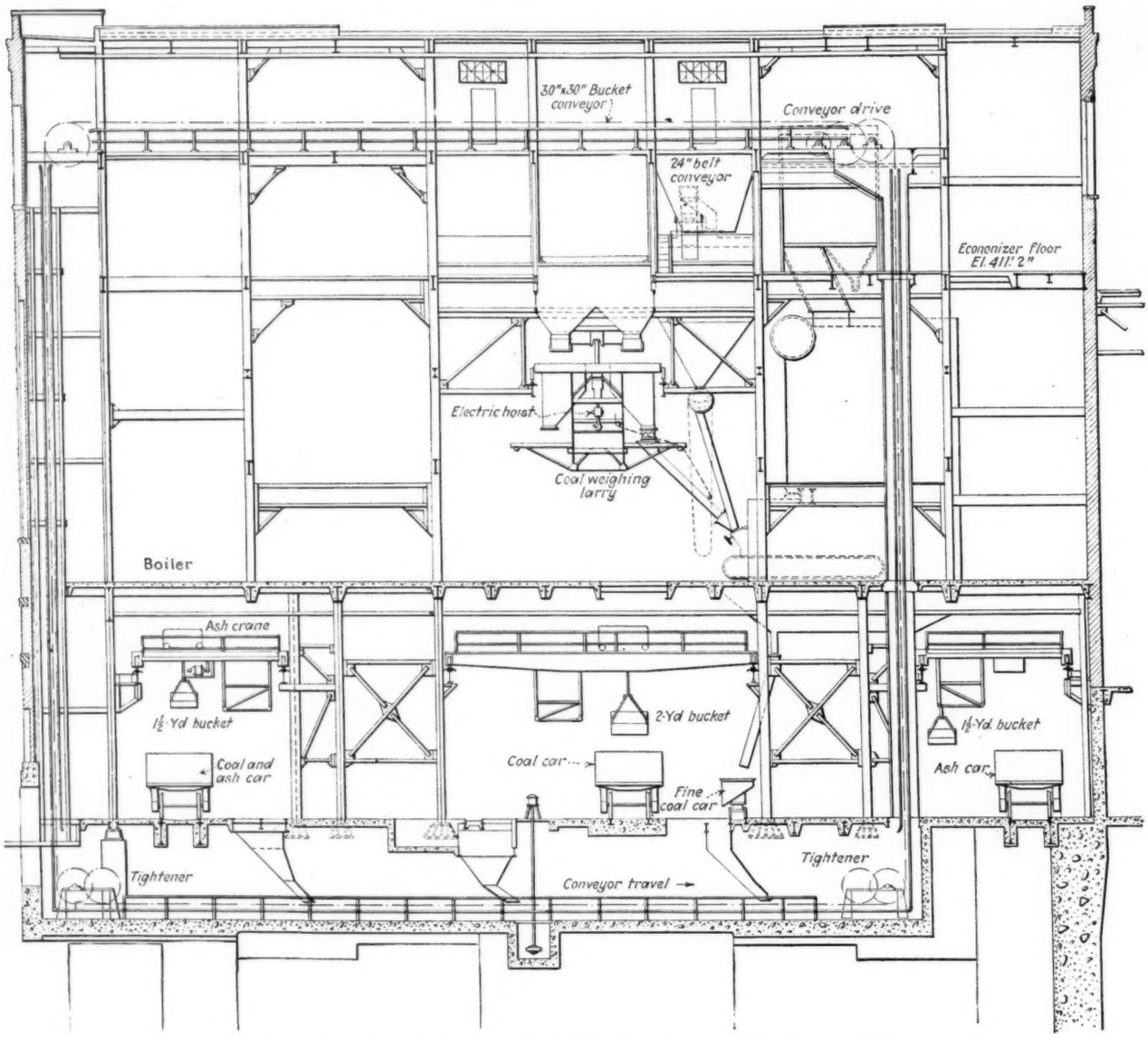


FIG. 5—CROSS-SECTION OF PLANT SHOWING COAL CONVEYING EQUIPMENT

coal here must be unloaded and reloaded with a locomotive crane before delivery to the power plant.

It should be pointed out that in this outside project the use of a revolving car dumper is contemplated. It is to be placed at the end of one of the elevated tracks, so that coal for immediate consumption can be emptied directly into the hopper supplying the cross-belt leading to the plant.

As an additional safeguard against shutdown provision has been made for quickly converting all or any part of the furnaces from coal to oil burning, should any shortage of coal occur. Storage capacity for 210,000 bbl. of oil is provided, 180,000 bbl. of this being at the station and the remaining 30,000 bbl. at a point some two miles distant and connected by pipe line. Normally, the oil stored at both places is used for the central heating system operated by the company for heating the downtown district. Electrical pumping equipment is installed at both storage places.

As mentioned previously, in case of a coal shortage the entire supply of stored oil is available for burning under the boilers at Northeast Station. A permanent installation of heaters and burner pumps, together with the necessary oil-distributing system and steam-atomizing lines, is installed in the boiler room. Special equipment has been designed which permits the conversion from coal to oil furnaces on exceedingly short notice. The stokers are not removed, the oil burners being above a floor laid over the top of the grates. The air for the burners is drawn through ducts between this floor and the grates, keeping them cool and preheating the air for combustion.

On two different occasions in the last three years the station has burned oil under some of the boilers, and creditable efficiencies were obtained considering the somewhat reduced furnace volume due to building the oil furnaces on top of the stokers.

Succeeding articles will cover the high-pressure piping features, hydraulic operation of valves, the heat balance of the station and the electrical department of the plant.

Responsibility for a section of such advanced design lies primarily with Joseph F. Porter, president of the company; H. C. Blackwell, vice-president and general manager; and Edwin Jowett, superintendent of production. The new electrical design is to be credited to L. R. Frisby. Sargent & Lundy, of Chicago, were the consulting engineers.

PRINCIPAL EQUIPMENT IN NEW ADDITION TO BOILER ROOM OF NORTHEAST STATION

GENERAL

Location of plant	Kansas City, Mo.
Character of service	Light and power
Capacity of new generating unit, kw.	30,000
Boilers installed	4
Turbine room (extended), ft.	96½
Boiler room (extended), ft.	171
Distance from condenser floor to turbine platform, ft.	57
Distance from ash track to boiler room floor, ft.	30
Width of firing aisle, ft.	28

BOILERS AND SUPERHEATERS

Manufacturer	Babcock & Wilcox Co.	Heine Boiler Co.
Type	Cross-drum water-tube	Cross-drum water-tube Sectional header type
Number installed	2	2
Steam-making surface per boiler sq.ft.	12,705	12,743
Grate area per boiler, sq.ft.	One 336 and one 340	One 336 and one 340
Ratio steam-making surface to grate area	37.8 — 37.3	37.9 — 37.4
Furnace volume, cu.ft.	One 4,782 and one 5,270	One 4,214 and one 4,738
Ratio steam making surface to furnace volume	2.7 — 2.4	3.0 — 2.7
Ratio furnace volume to grate area	13.0 — 15.0	12.5 — 13.9
Size of tubes, in.	4	3½
Boiler operating pressure, lb. gage	280	280
Type of superheater	Integral	Integral (Foster)
Manufacturer	Babcock & Wilcox Co.	Power Specialty Co.
Location of superheater	Above 4th row tubes	Between 1st and 2d. pass.
Superheating surface, sq.ft.	2,475	5,748
Ratio steam-making surface to superheater surface	5	2.2
Superheat, deg. F.	250	250
Total steam temp., deg. F.	650	650

[STOKERS]

Manufacturer	Illinois Stoker Co.	Combustion Engineering Corp.
Type	Forced-draft chain grate	Forced-draft Coxe traveling grate
Number of stokers	4	4
Number of air zones per stoker	8	6
Grate area per stoker, sq.ft.	168	170
Grate area per boiler, sq.ft.	336	340
Drive direct current (motors per boiler)	2	2
Arch radial end	M. H. Detrick Co.	Liptak Fire-Brick Arch Co.
Width of arch	24 ft. 10 in.	24 ft. 10 in.

MISCELLANEOUS EQUIPMENT

Number	Equipment	Type	Size	Manufacturer
1	Extraction heater	Closed	1,200 sq.ft.	Alberger Pump & Cond. Co.
1	Feed water heater (gland)	Closed	250 sq.ft.	Alberger Pump & Cond. Co.
1	Boiler feed pump	Motor driven, 300 hp.	700 g.p.m.	De Laval Steam Turbine Co.
4	Boiler soot blowers	Valve-in-head	24 units per boiler	Diamond Power Spec. Corp.
1	Air compressor	2-stage	13 x 8 x 10 in. 370 cu.ft. per min	Worthington Pump & Mach. Corp.

VALVES, METERS, PIPINGS, ETC.

Equipment	Manufacturer
Feed-water regulators and drainage control	"S-C" Regulator Mfg. Co.
Safety valves	Consolidated Safety Valve Co.
Blow-off, master valves	Yarnall-Waring Co.
Blow-off individual valves	Edward Valve & Mfg. Co.
High-pressure steam gate valves and piping	Crane Co.
Balance of valves	Edward Valve & Mfg. Co.
Sargol welding joints	Crane Company
Pipe coverings	Armstrong Cork Co's Non-Pariel
Draft gages	Defender Automatic Regulator Co.
Indicating steam gages	Crosby Steam Gage & Valve Co.
Recording thermometers	Brown Instrument Co.
Feed water meters (Venturi)	Builders Iron Foundry
Feed water make-up heater	H.S.B.W.–Cochrane Corp.
Steam-air flow meters	Bailey Meter Co.

ECONOMIZERS

Manufacturer	Babcock & Wilcox Co.	Power Specialty Co.
Type	Counterflow	Counterflow
Location	Above boilers	Above boilers
Heating surface, sq.ft.	6,250	8,100
Ratio steam-making surface to econ. surface	2.03	1.5

DRAFT EQUIPMENT

	Induced	Forced
Manufacturer	American Blower Co.	American Blower Co.
Type	Sirocco	Sirocco
Capacity, cu.ft. per min.	120,000	98,000
Number of fans	4	4
Drive, motors, hp	Two 282 and two 225	One 215 and three 125

CHIMNEY

Type	Self-supporting steel
Number of boilers per stack	2
Height above grate, ft.	123
Diameter of tip, inside, ft.	10
How supported	Superimposed on building steel structure

COAL HANDLING

Belt conveyor, 24 in. x 165 ft. long	Link Belt Co.
Rated capacity, 300 ft. per min., tons per hour	125
Motor driven, 7½ hp., 1140 r.p.m. (24 to 1 reduction	
Peck carriers, two, each 400 ft. long, rated capacity 120 tons per hour, travel 45 ft. per min.	

AIR HEATER

Manufacturer	Combustion Engineering Corp
Type	Steel plate
Size, sq.ft.	9,600

HOUSE SERVICE PUMPS

Manufacturer	Ingersoll-Rand Co.
Number	1
Capacity, gal. per min.	1,000
Head, ft.	165
Number of stages	1
Drive motor hp	75

BILGE PUMPS

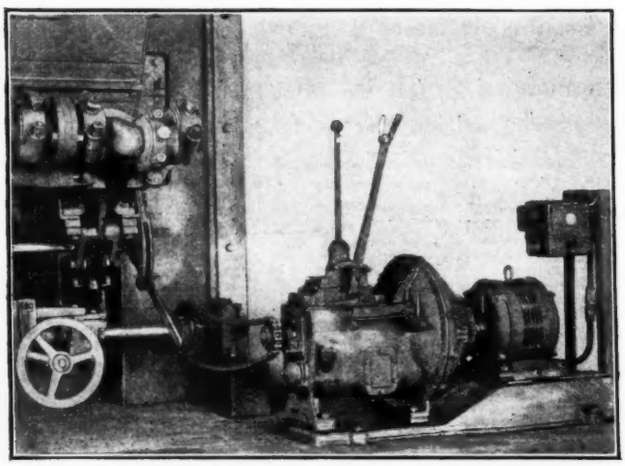
Number	2	1
Manufacturer	Worthington Pump & Mach. Corp.	Worthington Pump & Mach. Corp
Capacity, gal. per min.	500	100
Head, ft.	35—55	20
Type	Vertical submerged	Vertical submerged
Drive, motor, hp.	20	3

Alternating-Current Versus Direct-Current Motors for Stoker Drive

Types of Motors—Application of Variable-Speed Transmission and Selective Gears—Factors to Consider When Selecting Motors

BY W. E. DOUGLAS AND HARRY H. BATES*

IN A generating station the load, except in stations used for base load only, varies greatly for different hours in the day. This variation requires a corresponding variation in steam demand. The amount of steam generated is in some proportion to the weight of the particular coal burned under the boilers, which in turn depends on the amount of air supplied to burn the coal. It is important that the fuel be fed to the furnace no faster than it is consumed. It is, therefore, apparent that the stoker drive should have



INDUCTION MOTOR DRIVING MULTIPLE-RETORT STOKER THROUGH SELECTIVE-GEAR TRANSMISSION

a wide range in speed, preferably no less than four to one. The greater this ratio and the smaller the increments of speed adjustments the more satisfactory the operation of the stoker will be, provided the control system is not too complicated. It is always desirable to have as near a continuous speed range as possible, since a speed range made up of steps is rarely, if ever, entirely satisfactory.

In a power station with its turbo-generators supplying alternating current it would seem that alternating current would be used generally for stoker drive, but alternating-current motors do not have their best applications where wide speed variation is required. In order to use alternating current and avoid the complications of motor-generator sets or synchronous converters for supplying direct current, various methods are used. It is to be remembered that the modern stoker is primarily a constant-torque machine, regardless of the speed at which it runs.

The methods of stoker driving are as follows:

A. Constant-speed motor with a mechanical device that will give a wide range of speed.

B. A wound-rotor induction motor having a speed range of two to one by secondary-resistance control combined with a selective-gear transmission, preferably of four speeds.

C. A four-speed squirrel-cage motor giving speeds corresponding to 6, 8, 12 and 16 poles, or speeds of approximately 1,200, 900, 600 and 450 r.p.m. on 60 cycles, this motor to have two- or four-speed selective-gear transmission. This device will give six to twelve fixed speeds if the gears are properly proportioned.

D. A commutator-type alternating-current motor.

E. A two-speed wound-rotor motor giving a speed range of 1,200 to 600 r.p.m. by inserting resistance in the secondary and then pole changing to get 600 r.p.m. synchronous speed and reinserting resistance in the secondary to get from 600 to 300 r.p.m.

F. Other methods of mechanically obtaining variable speeds have been proposed and are in use, but in these isolated cases efficiency must be sacrificed to the extent that they will not receive further consideration.

CONSTANT-SPEED STOKER MOTORS

There are a number of constant-speed stoker motors in operation, where the variation in speed is obtained by a speed-changing device. The principal form of this drive is the combination of a constant-speed motor and a Reeves transmission. The chief objection to its use is the large amount of floor space required. It is, however, an extremely satisfactory piece of equipment from the performance viewpoint. The operating range is not limited to fixed speeds. The principle of this device consists of movable truncated cones arranged to move in or out on the driving and driven shafts, causing the belt, which is especially designed for the service, to ride on a larger or smaller diameter.

SELECTIVE-GEAR TRANSMISSION

A compact form of 2 to 1 variable-speed wound-rotor motor and selective-gear transmission is to be found in the transmission that is marketed by the Westinghouse company. It has four speeds forward as follows: 1 to 5.35; 1 to 2.84; 1 to 1.76; 1 to 1.00.

In addition to this, a reverse is also added, so that an obstruction in front of a ram may be removed by simply reversing the mechanism. This device gives, with a 2 to 1 variable-speed motor, a continuous speed range of 10.7 to 1. A clutch is provided, so that the motor can operate while any combination of gears is being made. All bearings are of the roller type and spur gears are used, making the efficiency of the drive high.

SQUIRREL-CAGE INDUCTION MOTORS

The third method is the four-speed squirrel-cage induction motor, which is similar in appearance to a standard type. Two separate windings are used to

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obtain the various pole combinations, one for four and eight poles and the other for six and twelve poles. Since four fixed speeds are not sufficient to assure successful stoker operation, a mechanical gear shift is required to obtain additional speeds. The first cost of this type of drive is too great and is seldom used.

Commutator-Type Alternating-Current Motors

Commutator type alternating-current motors for a long time were not seriously considered for any sort of drive, on account of their inherent troubles from commutator wear and sparking at the brushes. In the last few years there has been a growing demand in industrial plants for alternating-current motors having speed regulation over a wide range with small increments without the reduction in efficiency involved in the use of wound-rotor induction motors with secondary-resistance control. This has led to the development of the adjustable variable-speed brush-shifting motor having limited series characteristics. The type of motor is not especially applicable for stoker drive, because its high first cost and its complicated construction and control make it unsuitable for boiler-room applications. The commutator type also has the series characteristic that a given point on the control does not fix a definite speed if for any reason the torque should vary.

Two-Speed Wound-Rotor Induction Motors

The fifth method for stoker drive referred to as item E is the most flexible and satisfactory method of using an alternating-current motor when a selective-gear transmission is not part of the stoker-driving equipment. This arrangement lends itself readily to either manual or automatic operation, but has the one objection common to all wound-rotor alternating-current motor drives; namely, the difficulty experienced in determining the proper resistance for the secondary circuit. The power required to drive a stoker cannot be predetermined with the fine degree of accuracy necessary for the selection of the resistances, and in many cases experiment on the actual stoker installation must be resorted to before the correct resistances are finally determined. While this type of motor is the most desirable of the alternating-current motors when the motor alone makes up the driving equipment, it must be remembered that the constant- and two-speed motors used in connection with the gear transmissions already referred to are more satisfactory from the viewpoint of stoker performance.

Among the large power stations using the wound-rotor motor with the 4 to 1 speed range, are the West Penn Power Co., Springdale Station; United Electric Light & Power Co., Sherman Creek Station; Pennsylvania Railroad, Altoona, Pa.; and Columbus, Delaware & Marion R.R., Marion, Ohio.

In general, the alternating-current motor has in its favor the fact that no converting apparatus is required and in all cases, except that of the brush-shifting motor, commutators, which are at least a potential source of troubles, are eliminated.

Relative Advantages of Alternating-Current and Direct-Current Stoker Drives

While alternating-current motors comprise the larger proportion of stoker-motor drives, the direct-current motor has been used with more efficient results on many stoker installations. It has already been pointed out that a minimum speed range of 4 to 1 is required. This range can be obtained with direct-current motors by means of shunt-field control entirely or by combined field and armature control. The latter alternative will in some cases allow a smaller motor frame to be used, but the use of armature control has the objection that to obtain definite speeds the motor load must be definitely known. The same difficulty that occurs in the selection of resistance for the four-speed wound-rotor alternating-current motor, is experienced in the selections of resistances for armature control with direct-current motors. Calculations for the power required to drive a stoker are not within the limits of accuracy desired for control design, and if the armature resistance is calculated on a certain speed-torque curve, which is not obtained in actual operation of the stoker, the resistance grids will probably have to be changed. A change of grids must also be made in case it is found the torque requirements of the stoker decrease from that of the initial operation, due to the "wearing in" of the stoker castings.

The shunt-wound direct-current motor with all field control has many of the requirements that are desirable for stoker application. The speed range is wide and continuous and is an especially commendable feature. A definite speed is obtained for a given controller position, the control is simple and easily arranged for automatic regulation, and the efficiency is relatively high over the entire speed range. With a motor of these characteristics variable-speed devices and selective-gear transmissions are unnecessary.

Direct Current Motor Drives at Higher Efficiency

Assume a 15-hp. motor operating at a torque equivalent to 10 hp. at full speed, then the efficiencies between the direct-current motor with all field control and a two-speed wound-rotor motor would compare as follows:

Speed R.p.m.	Direct-Current Motor and Control, Per Cent	Alternating-Current Motor and Control, Per Cent
1,200	82	79
1,000	80	68
800	78	54
600	76	79
500	74	68
400	72	54
300	70	40

In order to determine which type of drive shall be used for a given installation, a comparison should be made including the initial cost, fixed charges on the total investment, cost of the losses and the suitability of the equipment to the local operating conditions encountered. The average speed at which the stoker is to operate, determined from a curve in which speed is plotted against time for a given day or longer period, must be the basis for the comparison. In the initial cost of the direct-current motor equipment, provisions for a spare motor-generator set must be made. In estimating the cost of a driving equipment, which includes a selective-gear transmission, it must be remembered that the gear transmission allows the use of a smaller motor and much less control apparatus, because, when no transmission is used, a motor of larger capacity than is required at rated speed must be used in order that it will be able to deliver the relatively high torques required at low motor speeds. In conclusion it can be said that where direct-current is available without resorting to special converting apparatus, the direct-current shunt-wound motor with all field control is best suited for stoker service.

Calumet & Hecla Large Mixed Pressure Turbines

Two cylinder, mixed-pressure turbines utilizing exhaust steam from a number of copper stamp heads, with supplementary supply of live steam first passing through a high-pressure cylinder. The regulating gear is of unusual interest as it must control not only high-pressure inlet and bypass valves, but also two inlet valves admitting low-pressure steam to the low-pressure cylinder.

AT THE power plant of the Calumet & Hecla Mining Co., Lake Linden, Mich., are two mixed-pressure turbines that are of unique design, with unusual regulating gear. These machines are considered to be the largest of their type, one being rated at 7,500 kw. and the other at 10,000 kw., and although they have been installed for a number of years, neither machine has been given previous publicity. Their function is to take exhaust steam from 28 stamp heads, which is supplemented when necessary with live steam from the boilers to generate three-phase 25-cycle current at 4,000 volts for the power, pumping and lighting loads of the numerous copper mines worked by the company. The speed of the machines in 1,500 r.p.m.

Fig. 1 is a view of the smaller unit and Fig. 2 a plan view with cover removed. It will be seen that the turbine has separate high- and low-pressure cylinders, the two spindles being connected by a flexible coupling and the generator to the low-pressure spindle by a second flexible coupling. This means that each rotor is carried in its own pair of bearings with six bearings to the machine. Each unit is served by a surface condenser with standard auxiliary equipment.

The high-pressure cylinder of the turbine uses live steam from the boilers at a pressure of 170 lb. gage per square inch, and as this steam exhausts from the high-pressure cylinder, it mixes with the exhaust steam from the copper stamp mills at a pressure of 16 lb. abs. As long as there is a sufficient supply of exhaust steam from the stamps, the unit is operated entirely by this exhaust steam in the low-pressure cylinder, but when the supply is insufficient to carry the load, the exhaust steam from the stamps is supplemented by a sufficient quantity of high-pressure steam which first passes through the high-pressure cylinder. On account of the large volumes of steam passing through the low-pressure cylinder, the blading is arranged on the double-flow principle. Incidentally, the low-pressure cylinder is large enough for the low-pressure end of a standard high-pressure condensing unit of 25,000 kw. capacity.

All the steam is exhausted from the stamps into a large common header which leads to the turbine. Although the stamps are more or less intermittent in their operation, their number is so great that a fairly constant supply of exhaust steam is available and the regulation has been designed to maintain a constant back pressure at the stamps. This is made possible by the supplementary supply of live steam, which, after passing through the high-pressure cylinder, mingles with the steam coming from the stamps before it is admitted to the low-pressure cylinder. All this steam passes through two 34-in. valves which govern the

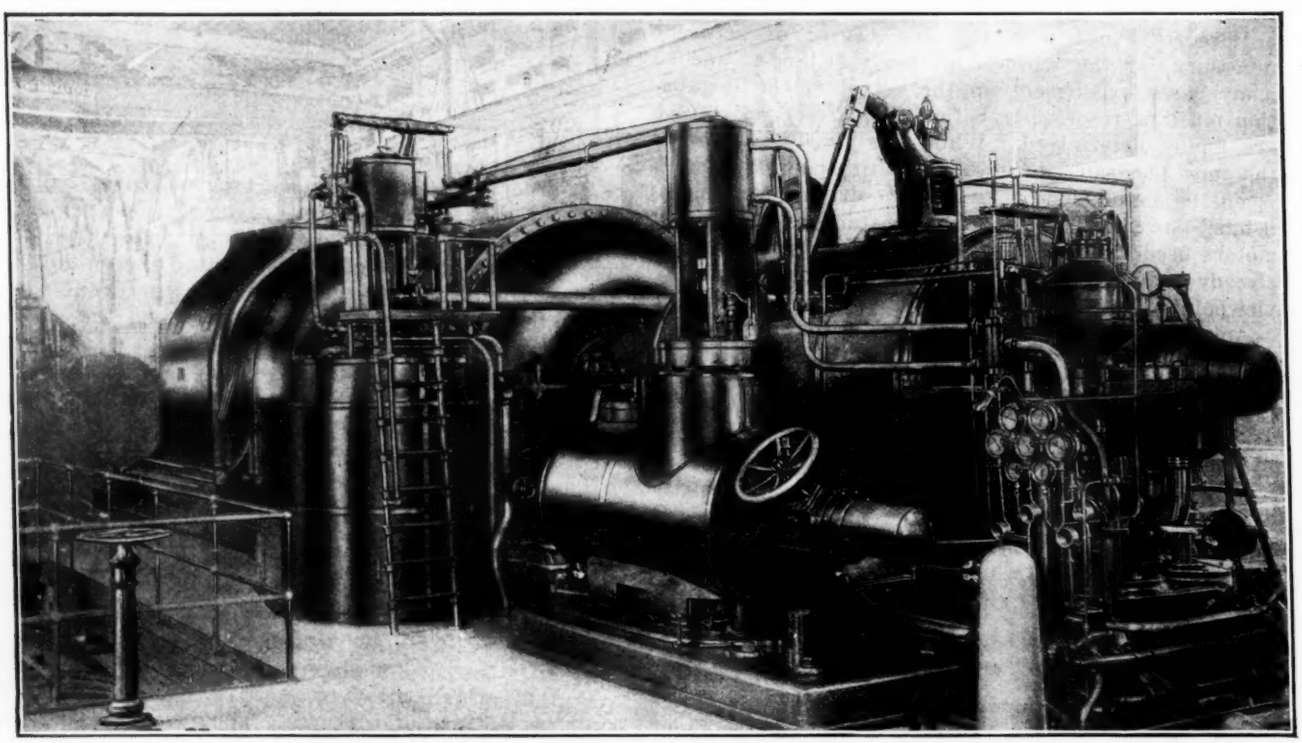


FIG. 1—ONE OF THE MIXED-PRESSURE TURBO-GENERATOR UNITS AT THE CALUMET AND HECLA PLANT

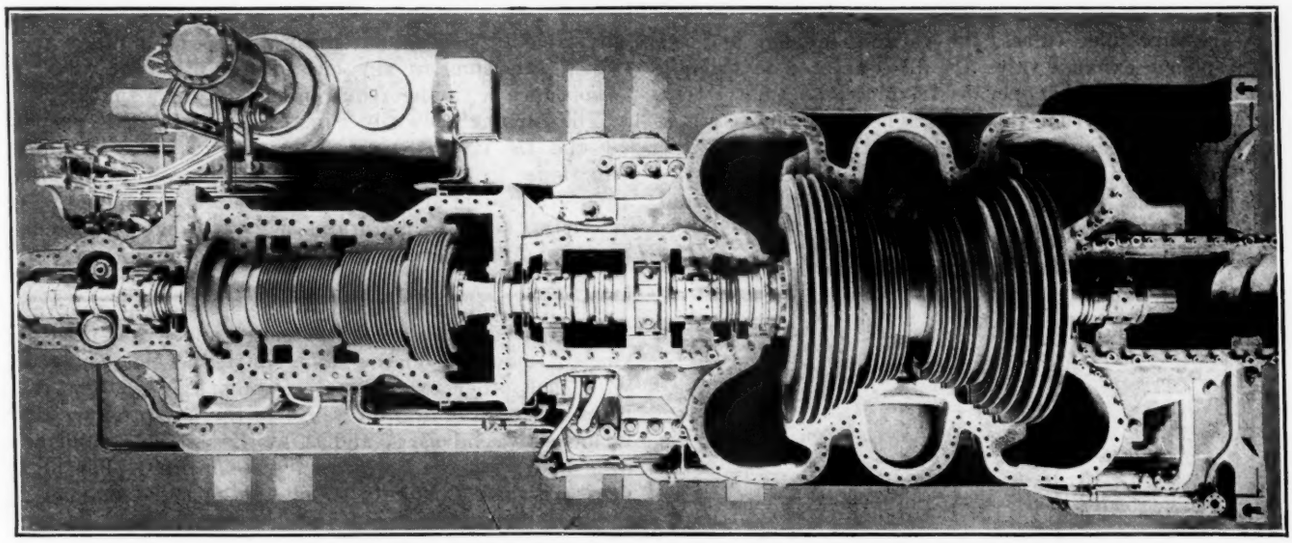


FIG. 2—UPPER HALF OF CASING REMOVED TO SHOW INTERIOR ARRANGEMENT

admission of the steam to the low-pressure cylinder. One of these valves is shown in Fig. 1 at the center of the machine, and the other is on the opposite side of the unit, the cross-shaft connecting the two valves so that both may be operated from the same mechanism, visible in the photograph.

These two low-pressure valves are operated by the steam pressure in the low-pressure exhaust line through suitable oil-operated valve gear. These valves always maintain pressure in the exhaust line and prevent the formation of a vacuum back to the stamps that might otherwise exist under certain conditions of light load on the turbine. They are attached to the governor so that under all conditions the machine is under regulation.

Layout of Regulating Gear

As the regulating gear on the two-cylinder mixed-pressure turbine is of necessity more complicated than is usual for the control of steam turbines, inasmuch as it must control not only the high-pressure inlet and bypass valves, but also two inlet valves admitting low-pressure steam to the low-pressure cylinder, it is shown diagramatically in Fig. 3. The centrifugal governor whose center line is at *A* is driven through spiral gears from the turbine shaft *B*. The movement of the governor acting through levers *C* operates an oil relay valve *D* which in turn controls the flow of oil under pressure to the relay piston *E* mounted on the high-pressure inlet valve stem *F* and controls the flow of high-pressure steam through the high-pressure inlet valve *G* to the high-pressure cylinder.

Control of the bypass valve *H*, which is on the top of the high-pressure cylinder, is accomplished through lever *J* and connecting rod *K* to lever *L*, which acts directly on the bypass valve stem.

The two low-pressure inlet valves, one of which is shown at *M*, control the admission of steam to the low-pressure cylinder. This control is accomplished through the pressure piston *N*, which is supported by pressure existing in the low-pressure steam line ahead of the low-pressure inlet valves and operates through rods and relay levers to an oil relay valve and relay cylinder actuating the low-pressure inlet valves proper. The low-pressure regulating system is under the control of the same centrifugal governor controlling the admission of steam to the high-pressure cylinder. This control is accomplished by a suitable connection between levers *J* and *O*.

To understand fully the working of this system, it must be borne in mind that the steam pressure under the pressure piston *N* is at all times the same as the pressure in the low-pressure steam line ahead of the low-pressure inlet valves and increasing pressure will open the low-pressure inlet valves unless otherwise controlled. This tendency is counteracted by the action of lever *O* on the valve stem of the pressure piston, so that the governor depresses the pressure piston and controls the low-pressure inlet valves and the admission of low-pressure steam in proportion to the load.

It will be apparent that when the supply of low-pressure steam is insufficient to maintain the load, the pressure under pressure piston *N* falls and the inlet valves will close, resulting in a change in speed which will cause the governor to open the high-pressure inlet valve *G* until sufficient high-pressure steam is admitted to the high-pressure cylinder to maintain the load. The travel or lift of the high-pressure inlet valve is so arranged that considerable movement of the valve is possible before admission of the high-pressure steam. This over-travel of the high-pressure inlet valve is provided for the purpose of permitting the low-pressure inlet valves to act throughout their range before the high-pressure inlet valves come into action.

Safety Trip System Provided

To fully protect the unit from overspeeding, it was necessary to provide a complete safety trip system. In the high-pressure end of the high-pressure spindle a standard type of automatic stop governor is mounted, and this governor actuates the tripping mechanism and closes the high-pressure automatic stop and throttle valve when the speed of the turbine reaches a predetermined maximum. In addition there is also a tripping system operated by oil pressure from the same source as that which actuates the relay cylinders governing the speed of the unit. This oil-pressure system closes the 36-in. low-pressure throttle either by hand trip or by automatically shutting this throttle when the automatic stop governor already referred to operates. The

low-pressure inlet valves, the vacuum breaker and the atmospheric exhaust valve are all connected to this oil-pressure system and operate from the automatic trip. It will be seen from this that when the hand trip is operated or the automatic overspeed governor acts, the high-pressure throttle valve, the low-pressure throttle valve and the low-pressure inlet valves will close and

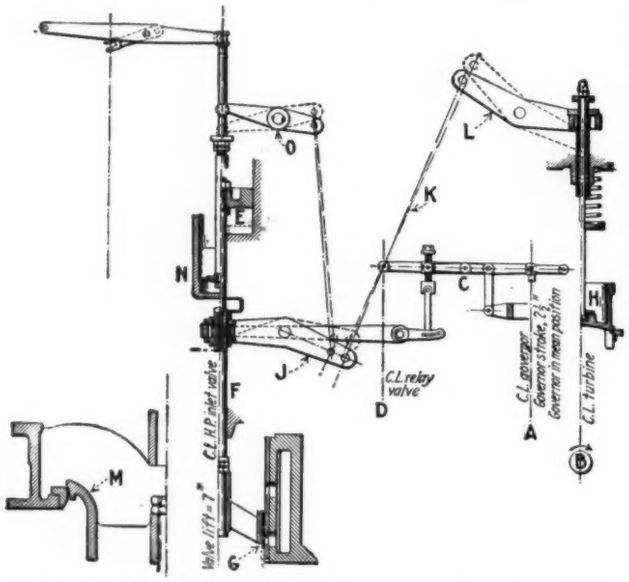


FIG. 3—DIAGRAMMATIC LAYOUT OF REGULATING GEAR

the vacuum breaker and the atmospheric exhaust valve will open simultaneously.

One of these units was installed in 1913 and the other in 1918. Throughout the period indicated, they have given excellent service and effected the economies anticipated. The conception of the entire plan is to be credited to Arvid Baalack, mechanical engineer, and F. N. Bosson, electrical engineer of the company. The turbines were designed and built by the Allis-Chalmers Manufacturing Company.

One Valve Gear Automatically Changes a Turbine into a High-, Low-, Mixed-Pressure or Extraction Type

A unique valve gear which may operate automatically in five different capacities, adjusts the turbine to the requirements both of the generator load and of the low-pressure system to which it is attached. Besides the usual turbine valve gear, consisting of centrifugal governor and hydraulically operated valve, this requires only two hydraulically operated valves. One of these valves is operated by means of a pressure regulator connected with the low-pressure system, and the second is linked with the high-pressure valve, and thus controlled by the centrifugal governor.

Variations in the demand of the low-pressure system, where an oversupply of steam sometimes existed, together with changes of load on a turbine bleeder-type unit rendered it advisable to use an automatically operated valve gear which functions in any one of five different ways, in accordance with the requirements of the situation.

The turbine shown in Fig. 1 is built for this purpose by the De Laval Steam Turbine Co. This not only functions in supplying the deficiencies of the low-pressure system or in utilizing the excess of steam when it occurs, but also maintains a fixed range of pressure at the point where it connects with the low-pressure system.

The turbine unit shown to the left of the diagram, Fig. 2, consists of a high-pressure and a low-pressure element mounted on the same shaft, but not connected with each other by internal steam passages. The connection from the high-pressure to the low-pressure unit includes two valves, *A* and *B*, at the extreme right and connected with the low-pressure steam line. The high-pressure valve *C* admits steam in the usual manner to the high-pressure element and is controlled by a centrifugal governor. Valve *B* is linked so that its operation is also controlled by the centrifugal governor. The valve *A*, Fig. 2, is not essentially a governing valve, but it is simply to control the pressure in the low-pressure system *J*. When the pressure in the low-pressure system is less than 5 lb., the valve *A* will remain closed. When the pressure tends to become greater than 5 lb., the valve *A* will open an amount to bypass steam to valve *B* sufficiently to hold the pressure in system *J* at 5 lb. The valve *A* does not function in any respect as a regulating valve for the turbine, but only as a valve to maintain 5 lb. pressure in the low-pressure system.

As long as the pressure in the system *J* is below 5 lb., the valve *A* will remain closed and the turbine will operate as a high-pressure machine only, as the steam exhausted through the passage *F* can pass out only through the low-pressure line *J*.

When the low pressure rises above this setting, the valve *A* begins to open and is automatically opened until the range of the pressure regulator is reached, which may be 2 or 3 lb. We will consider that the regulator is set to begin opening at 5 lb. gage and completely opening at 7 lb. gage, in this discussion.

With no demand for process steam but with an appreciable load, the high-pressure element will exhaust into the line at *F* and build up a pressure, say 6 lb. This will open the valve *A* and make the turbine function as a straight high-pressure condensing unit, by admitting high-pressure exhaust into the low-pressure element.

Now, with a light demand for process steam the pressure would lower slightly in the low-pressure system,

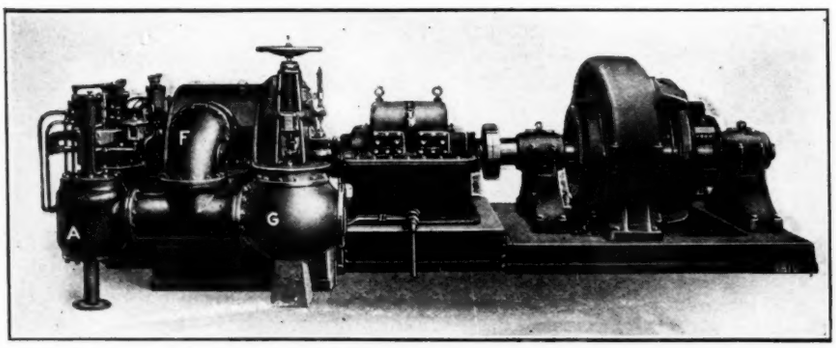


FIG. 1—HIGH-PRESSURE AND LOW-PRESSURE TURBINE COMBINED IN ONE CYLINDER FUNCTIONS IN FIVE SEPARATE CAPACITIES

say 5½ lb. The pressure regulator would therefore cause valve *A* to close somewhat. Owing to the throttling effect of *A* less steam would be received into the low-pressure turbine. The remaining part of the high-pressure exhaust then would go into the heating system. The unit would thus function as a bleeder turbine. Governing is still accomplished by valve *C*.

In order to operate as a mixed-pressure unit, suppose the demand at *J* for process steam ceased. The pressure at *J* would rise, so as to open *A* more, and the unit again would cut over to the straight condensing high-pressure condition. If process steam supplied by other units is now discharged into the low pressure system, pressure at *J* then will rise farther. Valve *A* will open still wider, admitting steam from the system into the turbine. Operation will then be that of a mixed-pressure unit, governed by the centrifugal governor, throttling at *C*. Low-pressure steam admitted by valve *A* is restricted if the pressure at *J* is within range of the regulating pressures, from 5 to 7 lb.

If the load gradually drops off, less steam will be exhausted from the high-pressure unit. Finally, a point will be reached where the excess process steam will carry the load without high-pressure steam supply. The valve *C* will close. The turbine will then be a low-pressure condensing unit. Throttling or governing will be done by the valve *B* actuated by the centrifugal governor. These two valves are linked together so that *B* is approaching the closed position when *A* shuts off. With further decrease of load or increase of process pressure, the governing is accomplished by the valve *B*.

Of course, if there were no need of the low-pressure steam for a while, the hand valve *G*, Figs. 1 and 2, could be closed and the valves *A* and *B* unlinked so that they would remain open. In such a condition valve *C* would do all the throttling in the usual manner for a high-pressure condensing unit.

Summarizing the operations, for the turbine to run non-condensing the pressure in the low-pressure line must be less than 5 lb.—*A* and *B* closed, *C* governing.

When running as a bleeder-type turbine, the low pressure must be greater than 5 lb. gage—valves *A* and *B* open and *A* perhaps, throttling; valve *C* will be open and the power demand must be greater than the high-pressure unit would generate in order to furnish the process steam from *F*, the high-pressure exhaust.

Mixed-pressure turbine operation requires the low-pressure system to be more than 5 lb.—valves *A* and *B* open, valve *C* throttling; power demand greater than surplus low-pressure steam will supply. Valve *A* may restrict steam supplied.

When operating as a low-pressure unit, the system pressure at *J*, Fig. 2, is greater than 5 lb. A lighter load than the low-pressure steam will supply causes the valve *C* to be closed by the governor. Steam is throttled by the valve *B*.

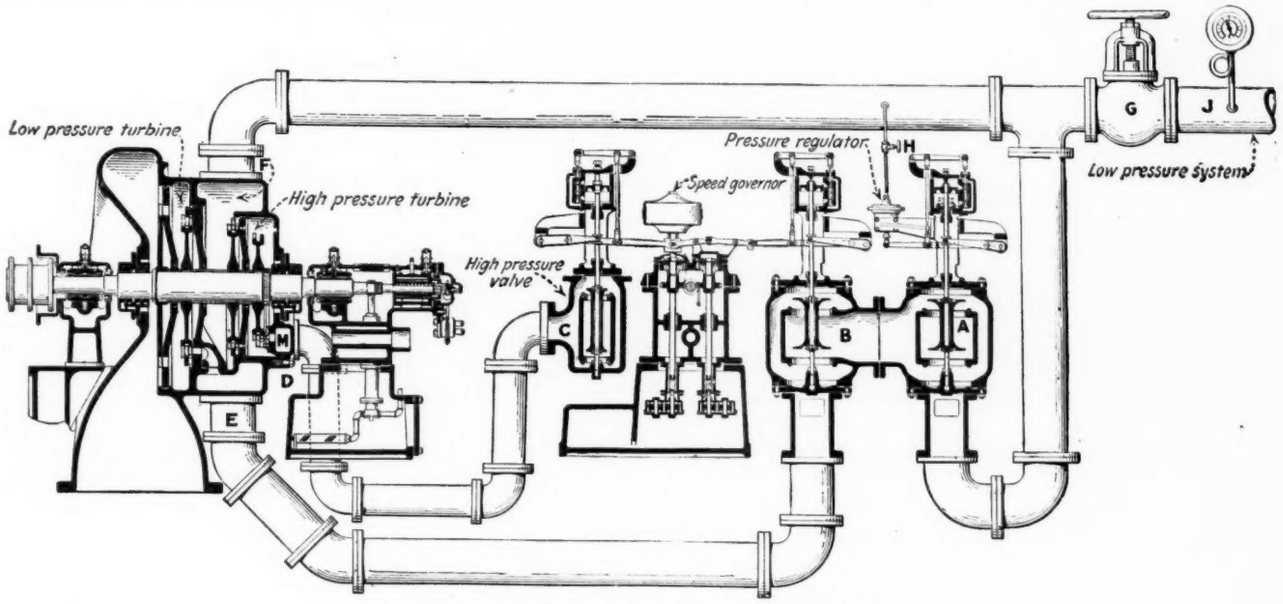


FIG. 2—DIAGRAM OF VALVE ARRANGEMENT
High-pressure turbine exhausts at *F*, into the heating system *J*. Valves *A* and *B* admit steam to the low-pressure element. Centrifugal governor operates valves *B* and *C*. Pressure regulator controls *A*.

As a straight high-pressure non-condensing turbine the low-pressure system is above 5 lb. pressure—valves *A* and *B* are open, valve *C* throttling. The load is such as to require the high-pressure element only in supplying process-steam demand.

The concentration or strength of the pure sulphuric acid, and also of electrolyte, is determined by obtaining its specific gravity, so that this quantity is at all times of importance in storage-battery work. Heavy liquids have a high specific gravity and lighter ones a lower specific gravity. One method of determining the specific gravity of a liquid such as sulphuric acid, where a hydrometer is not available, is to weigh a bottle, fill it with the liquid and then weigh it again. Empty the bottle and fill with distilled water of 39.20 F., exactly as full as it was of the liquid, and weigh. Subtract the weight of the bottle from both weights last obtained, and divide the weight of liquid by the weight of water; the quotient is the specific gravity of the liquid. The accuracy of the result will depend upon the accuracy of the weighing.

The preventable fuel waste by itself would pay considerable more than half of the interest on the total debt of our country.

Numerous Small Plants Supply the Majority of Power for Illinois Industries

Three-quarters of all prime-mover capacity in privately-owned plants are steam engines, one-sixth steam turbines, one-twelfth internal-combustion engines, while waterwheels are less than one-hundredth

ALTHOUGH Illinois, known as the Prairie State, extending between the latitudes of Lynn, Mass., and Norfolk, Va., is well adapted to agriculture, it nevertheless is one of the leading states of the Union in the value of its manufactures. Meat and food, coal, agricultural implements and products related to iron and steel are those of the leading industries. The industrial survey of the various states for 1920 which *Power* and the *Electrical World* are making, indicates that Illinois stands fourth in total prime-mover horsepower installed and the amount of energy used generally. At the present time this state is exceeded by Pennsylvania, New York and Ohio in this respect. It may however, possibly be exceeded by other states when the industrial survey is further advanced.

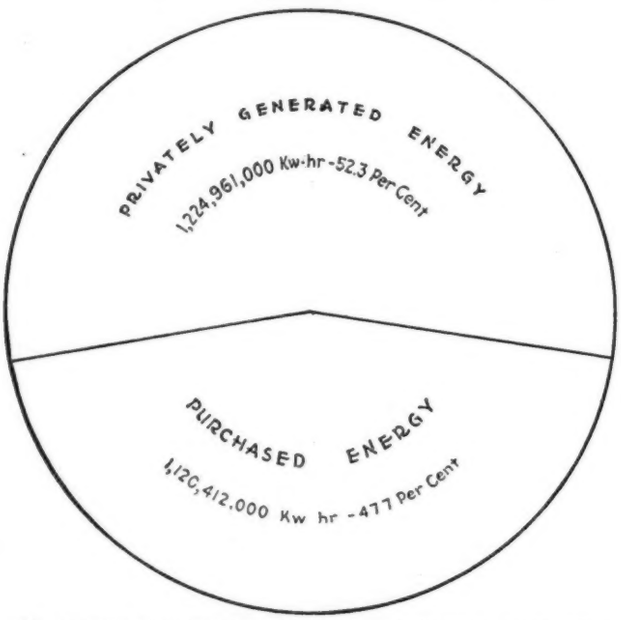


FIG. 1—PURCHASED ELECTRICAL ENERGY IS LESS THAN PRIVATELY GENERATED

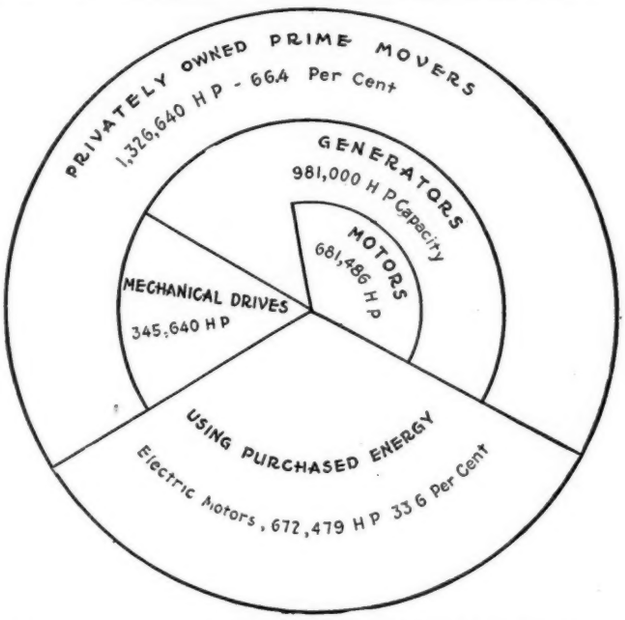


FIG. 2—PRIVATE PLANTS REPRESENT TWO-THIRDS INDUSTRIAL DRIVING CAPACITY

Two remarkable facts are indicated by this survey. Illinois contains approximately 19,000 small plants, which is twice the number in New York, three times that in Pennsylvania and seven times that in Ohio or Massachusetts. Another noteworthy fact is that the energy furnished by the Illinois privately-owned plants exceeds by a small margin that purchased from public-service corporations. Fig. 1 indicates the relative proportion of privately generated and purchased electrical energy, the former predominating by about 5 per cent. This is the first of the principal states in which the survey indicates that privately generated energy is used to such an extent.

Electrical motors driven by privately generated energy are practically equal in capacity to those using purchased power, as shown in Fig. 2, the former being approximately 681,000 hp. and the latter 672,000 hp. The installed horsepower of prime movers is twice that of motors using purchased current. Mechanical drives form approximately one-fifth of the total driving power, so that the industries may be grouped, roughly, as requiring one-fifth mechanical drive, two-fifths electrical motors using privately generated energy, and two-fifths electrical motors using purchased energy.

The principal industries, with regard to the total amount of prime-mover horsepower, are iron and steel products, bituminous coal mines, food and kindred products, and chemical and allied products. The relative horsepower installed in each industry is illustrated in Fig. 3, as well as the distribution of prime movers in each case. It is notable that the largest industries generate more power than they purchase. The three principal industries each generate approximately twice as much electrical energy as is purchased, while miscellaneous chemical industries generate about three times as much energy as is purchased. Industrial groups of paper and printing, vehicles, petroleum, food, lumber and metal products, and quarries purchase the major portion of their electrical energy.

As might be expected in many small plants which the census of Illinois includes, steam engines represent the greater part of the prime-mover horsepower, being about three-fourths, with steam turbines next, being one-sixth. Internal-combustion engines represent one-twelfth of the entire capacity and waterwheels less than 1 per cent. The average steam-engine unit is 118 hp., the average turbine 430 hp., internal-combustion engine

TABLE I—TOTAL PRIME MOVER EQUIPMENT FOR 1920 IN INDUSTRIAL PLANTS OF ILLINOIS

Industry	No. of Plants in State	Total Hp. of Prime-Movers in Industrial Plants	Steam Engines		Steam Turbines		Internal-Combustion Engines		Waterwheels		Estimate of Boilers in Industrial Plants	
			No.	Hp.	No.	Hp.	No.	Hp.	No	Hp.	No.	Hp.
Agricultural implements	68	33,296	131	22,000	17	10,134	3	72	12	1,090	114	24,270
Chemicals and allied products (total)	897	103,412	846	76,678	116	25,000	29	1,732	1	2	489	114,638
Rubber and rubber products	20	460	2	450	0	0	1	10	0	0	2	438
Glass and glass products	97	8,217	26	4,717	3	2,500	8	1,000	0	0	28	6,500
Chemicals	531	36,797	335	31,468	11	5,143	9	184	1	2	190	45,000
Smelting and refining of metals	24	17,472	37	11,647	5	5,667	3	158	0	0	56	13.100
Artificial gas manufacture	70	21,282	288	14,869	80	6,187	5	226	0	0	113	26,300
Miscellaneous chemical industries	155	19,184	158	13,527	17	5,503	3	154	0	0	100	23,300
Electrical equipment and machinery	161	21,078	9	1,995	7	19,000	1	83	0	0	37	11,900
Food and kindred products	4,388	178,577	2,140	156,956	126	17,625	148	3,092	23	904	754	178,400
Iron and steel and their products	1,450	360,153	701	236,467	97	79,273	234	42,723	22	1,690	1,020	238,800
Leather and its products	354	15,427	107	12,524	11	2,890	1	13	0	0	62	12,720
Lumber and its products	961	51,675	713	47,803	9	2,849	49	843	4	180	321	63,150
Metals and metal products other than iron and steel	1,142	37,933	164	31,333	6	4,791	23	618	19	1,191	122	28,000
Bituminous-coal mines	499	205,777	1,609	186,926	36	17,725	88	1,126	0	0	1,138	243,000
Metal mines	6	30	1	30	0	0	0	0	0	0	1	35
Stone quarries	66	16,030	219	13,641	5	1,953	34	436	0	0	86	18,500
Miscellaneous mines and quarries	17	4,771	78	4,597	1	50	10	124	0	0	26	5,510
Petroleum and natural gas	236	35,326	170	3,588	0	0	1,723	31,738	0	0	20	4,260
Paper and printing	3,010	37,727	174	30,382	4	2,003	248	1,286	12	4,056	124	34,930
Railroad-shop construction and repairs	201	65,365	289	42,126	43	22,122	20	1,117	0	0	231	56,600
Stone and clay and their products	795	67,019	556	55,893	15	8,783	92	2,243	1	100	247	58,250
Textiles	1,613	11,939	48	10,085	2	1,450	7	154	1	250	49	11,330
Tobacco	1,182	0	0	0	0	0	0	0	0	0	0	0
Vehicles for land transportation	1,136	9,424	41	5,222	3	3,090	95	912	6	200	42	11,030
Miscellaneous	1,235	71,681	386	49,692	54	19,172	56	894	31	1,923	394	81,900
Total for all manufacturing industries, mines and quarries in Illinois	19,417	1,326,640	8,382	987,938	552	237,910	2,861	89,206	132	11,586	5,277	1,197,223

TABLE II—ESTIMATE OF THE USE OF ELECTRICAL ENERGY BY INDUSTRIAL PLANTS IN ILLINOIS IN 1920 AND 1921

Industry	Electric Generators (In Private Plants) Direct-Current No.	Direct-Current Total Rating, Kw.	Alternating-Current No.	Alternating-Current Total Rating, Kw.	Electrical Energy Consumed: Purchased from Public Utilities 1920, Kw.-Hr.	Generated in Private Plants 1920, Kw.-Hr.	Total Energy Consumed 1920, Kw.-Hr.	Total Energy Consumed 1921, Kw.-Hr.
Agricultural implements	39	7,930	12	9,790	35,000,000	41,100,000	76,100,000	34,200,000
Chemicals and allied products (total)	260	37,297	396	114,803	109,148,000	226,302,000	335,450,000	209,880,000
Rubber and rubber products	0	0	3	1,620	3,500,000	7,870,000	11,370,000	9,330,000
Glass and glass products	14	2,690	3	1,380	6,900,000	6,310,000	13,210,000	8,720,000
Chemicals	149	23,180	105	90,600	67,800,000	120,700,000	188,500,000	139,500,000
Smelting and refining of metals	11	2,240	4	2,780	5,920,000	11,630,000	17,550,000	4,030,000
Artificial-gas manufacture	4	437	1	873	2,108,000	3,792,000	5,900,000	5,800,000
Miscellaneous chemical industries	82	8,750	280	17,550	22,920,000	76,000,000	98,920,000	42,500,000
Electrical equipment and machinery	6	362	9	18,788	14,630,000	33,100,000	47,730,000	58,200,000
Food and kindred products	290	19,180	106	26,220	230,300,000	122,700,000	353,000,000	339,000,000
Iron and steel and their products	341	46,200	160	114,880	170,000,000	352,000,000	522,000,000	208,800,000
Leather and its products	176	15,600	0	0	8,700,000	16,340,000	25,040,000	26,300,000
Lumber and its products	49	4,580	27	6,020	18,800,000	10,500,000	29,300,000	25,200,000
Metals and metal products other than iron or steel	13	2,190	20	23,410	80,150,000	55,150,000	135,300,000	60,850,000
Bituminous-coal mines	513	88,300	322	63,300	57,100,000	132,200,000	189,300,000	207,500,000
Metal mines	0	0	0	0	2,680,000	0	2,680,000	1,152,000
Stone quarries	2	351	1	269	27,330,000	1,380,000	28,710,000	21,530,000
Miscellaneous mines and quarries	1	234	0	0	0	533,000	533,000	347,000
Petroleum and natural gas	1	152	0	0	102,000	34,000	136,000	128,000
Paper and printing	118	13,180	31	12,420	117,600,000	36,540,000	154,140,000	92,400,000
Railroad-shop construction and repairs	11	13,500	13	4,680	71,400,000	94,000,000	165,400,000	165,800,000
Stone and clay and their products	171	20,400	52	11,180	82,600,000	35,920,000	118,520,600	110,200,000
Textiles	27	927	42	6,783	28,520,000	9,800,000	38,320,000	38,250,000
Tobacco	0	0	0	0	102,000	0	102,000	99,000
Vehicles for land transportation	11	1,750	4	1,175	14,100,000	3,412,000	17,512,000	12,260,000
Miscellaneous	123	23,200	77	23,000	52,150,000	53,950,000	106,000,000	76,300,000
Totals for all manufacturing industries, mines and quarries in Illinois	2,152	295,333	1,272	436,638	1,120,412,000	1,224,961,000	2,345,173,000	1,688,396,000

TABLE III—ESTIMATE OF THE NUMBER AND RATING OF MOTORS INSTALLED IN THE INDUSTRIAL PLANTS OF ILLINOIS

Industry	Motors Run by Purchased Energy Number	Motors Run by Purchased Energy Total Rating, Hp.	Motors Run by Energy Generated in Private Plants Number	Motors Run by Energy Generated in Private Plants Total Rating, Hp.	Total Motors in All Plants Number	Total Motors in All Plants Total Rating, Hp.	Total Motors in All Plants Motors Under 5 Hp.	Distribution of Drives: Belt, Number	Distribution of Drives: Chain, Number	Distribution of Drives: Directly Connected, Number
Agricultural implements	2,045	21,312	1,620	24,979	3,665	46,291	918	1,666	110	1,889
Chemicals and allied products (total)	2,517	36,878	4,855	70,498	7,372	107,376	2,233	4,330	448	2,594
Rubber and rubber products	100	2,000	196	4,490	296	6,490	.....	.....	.....	.....
Glass and glass products	427	3,159	204	2,891	631	6,050	.....	.....	.....	.....
Chemicals	1,480	20,314	2,740	36,090	4,220	56,404	.....	.....	.....	.....
Smelting and refining of metals	115	3,934	332	7,725	447	11,659	.....	.....	.....	.....
Artificial gas manufacture	27	630	94	1,133	121	1,763	.....	.....	.....	.....
Miscellaneous chemical industries	368	6,841	1,485	22,659	1,853	29,500	.....	.....	.....	.....
Electrical equipment and machinery	2,036	11,582	2,890	18,286	4,926	29,868	3,420	3,531	56	2,339
Food and kindred products	13,030	116,276	5,925	61,920	18,955	178,196	8,350	11,365	2,480	5,110
Iron and steel and their products	9,360	133,713	10,380	215,618	19,740	349,331	4,970	8,952	596	10,192
Leather and its products	998	6,258	1,122	11,740	2,120	17,998	851	1,920	108	92
Lumber and its products	2,180	21,988	876	12,280	3,056	34,268	1,123	2,236	119	701
Metals and metal products other than iron and steel	5,580	53,280	1,575	16,756	7,155	70,036	3,718	5,114	357	1,694
Bituminous-coal mines	1,070	41,365	3,165	95,916	4,235	137,281	1,472	1,125	161	2,949
Metal mines	61	1,948	0	0	61	11,948	20	16	2	43
Stone quarries	293	12,880	25	819	318	13,699	110	88	12	218
Miscellaneous mines and quarries	0	0	26	400	26	400	9	7	1	18
Petroleum and natural gas	8	74	2	25	10	99	3	2	1	7
Paper and printing	11,750	45,746	953	14,223	12,703	59,969	6,465	10,200	543	1,960
Railroad-shop construction and repairs	2,860	48,311	4,025	63,712	6,885	112,023	715	1,657	228	3,810
Stone and clay and their products	1,443	37,950	581	16,466	2,024	54,416	648	1,158	256	610
Textiles	2,720	16,564	546	5,700	3,266	22,264	1,970	1,450	262	1,554
Tobacco	18	76	0	0	18	76	12	16	0	2
Vehicles for land transportation	2,450	19,028	367	3,254	2,817	22,282	1,360	1,713	155	949
Miscellaneous	6,730	47,250	5,610	48,894	12,340	96,144	6,900	6,756	817	4,767
Total for all manufacturing industries, mines and quarries in Illinois	67,149	672,479	44,543	681,486	111,692	1,353,965	45,267	63,302	6,712	41,498

31, and waterwheel 87. The distribution of prime movers in the remaining industries is clearly indicated in Fig. 3. Steam engines predominate in every industry with the exception of that including electrical equipment and machinery. In the latter, steam turbines supply nine-tenths of the prime-mover capacity and internal-combustion engines and waterwheels are not represented.

Internal-combustion engines, however, are prominent in the natural-gas and petroleum industries, as would be expected, and steam turbines and waterwheels do not appear here. In this group the internal-combustion engines represent nine-tenths of the entire horsepower.

Where small plants furnish such a large proportion of the energy, it would be probable that direct current would equal the entire capacity of alternating current or approach very close to it. It appears, in this case, that the ratio is approximately 3 to 4, or in other words, 3/7 approximately of the installed generator capacity is for direct current and 4/7 for alternating current. The exact figures are 295,333 kw. of direct-current generators which average 137 kw. each, and 436,638 kw. of alternating-current generators which average 340 kw. It must be remembered that a very small proportion of the returns were received from these industries. Smaller plants, as a rule, are less likely to send in returns, so that it is quite probable that the actual proportion of direct-current electrical generators is somewhat higher than the estimate indicates.

Motors operated by purchased energy total about 672,479 installed horsepower, and average between 10 and 11 hp. each. Motors of 681,486 hp. using privately generated current, however, average slightly over 15 horsepower.

Comparatively few companies reported on operating voltages in use, but returns indicate that in direct current 220 volts was used in the greatest number of plants, with 110 second. Two hundred and twenty volts alternating current appeared in the greatest number of reports, with 440 volts second. Sixty cycles, both for two-phase and three-phase, considerably outweighed other frequencies, although 25 cycles appeared in a few installations.

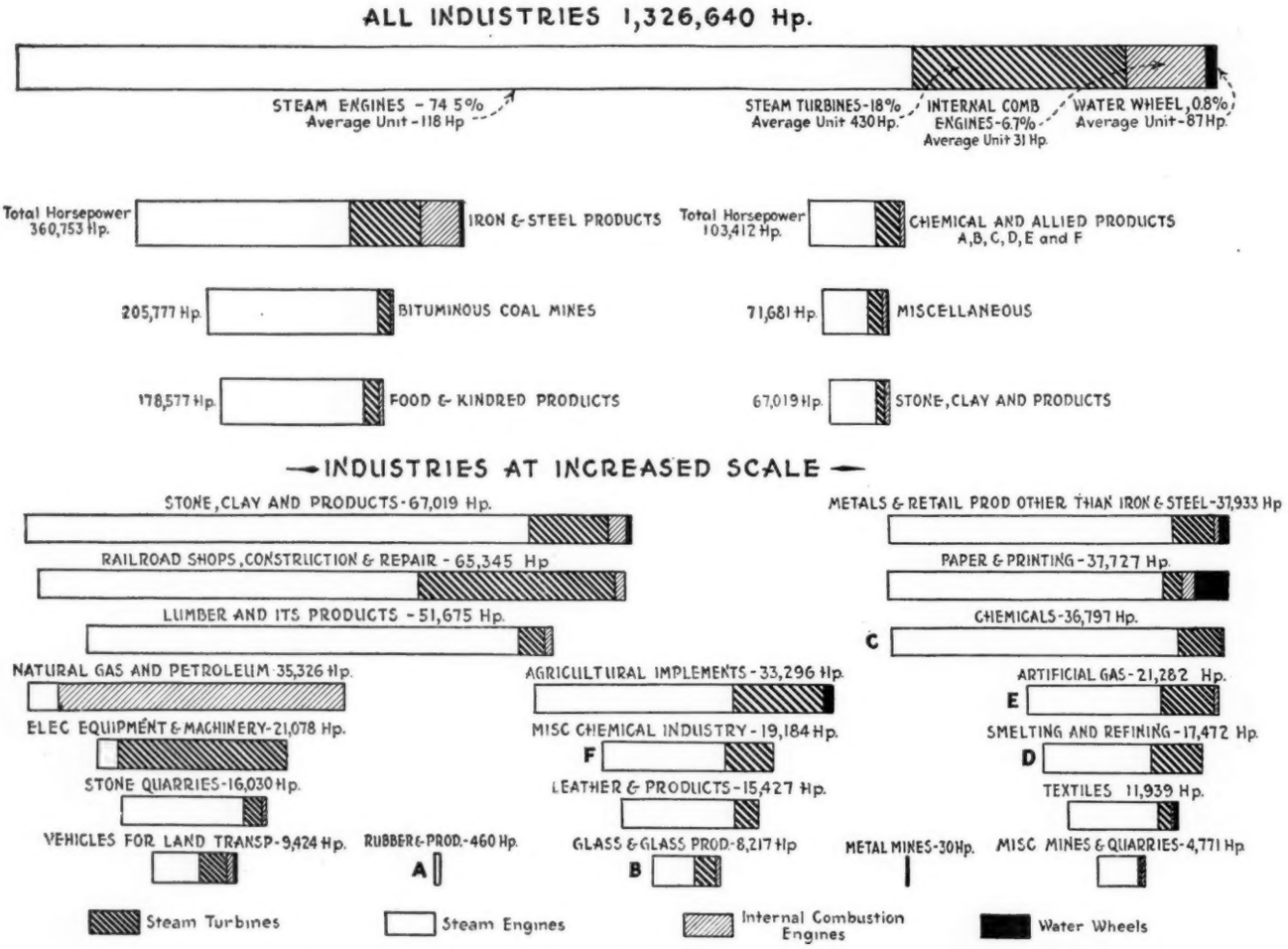

ALL INDUSTRIES 1,326,640 Hp.
STEAM ENGINES - 74 5% Average Unit - 118 Hp
STEAM TURBINES-18% Average Unit 430 Hp.
INTERNAL COMB ENGINES-6.7% Average Unit 31 Hp.
WATER WHEEL, 0.8% Average Unit-87 Hp.
Total Horsepower 360,753 Hp.
IRON & STEEL PRODUCTS
Total Horsepower 103,412 Hp.
CHEMICAL AND ALLIED PRODUCTS A,B,C,D,E and F
205,777 Hp.
BITUMINOUS COAL MINES
71,681 Hp.
MISCELLANEOUS
178,577 Hp.
FOOD & KINDRED PRODUCTS
67,019 Hp.
STONE, CLAY AND PRODUCTS
INDUSTRIES AT INCREASED SCALE
STONE, CLAY AND PRODUCTS - 67,019 Hp.
RAILROAD SHOPS, CONSTRUCTION & REPAIR - 65,345 Hp
LUMBER AND ITS PRODUCTS - 51,675 Hp.
NATURAL GAS AND PETROLEUM 35,326 Hp.
ELEC EQUIPMENT & MACHINERY-21,078 Hp.
STONE QUARRIES-16,030 Hp.
VEHICLES FOR LAND TRANSP-9,424 Hp.
RUBBER & PROD.-460 Hp.
A
AGRICULTURAL IMPLEMENTS - 33,296 Hp.
MISC CHEMICAL INDUSTRY - 19,184 Hp.
F
LEATHER & PRODUCTS - 15,427 Hp.
GLASS & GLASS PROD-8,217 Hp
B
METALS & RETAIL PROD OTHER THAN IRON & STEEL-37,933 Hp
PAPER & PRINTING - 37,727 Hp.
CHEMICALS-36,797 Hp.
C
ARTIFICIAL GAS - 21,282 Hp.
E
SMELTING AND REFINING - 17,472 Hp.
D
TEXTILES 11,939 Hp.
METAL MINES-30Hp.
MISC MINES & QUARRIES-4,771 Hp
Steam Turbines
Steam Engines
Internal Combustion Engines
Water Wheels

FIG. 3—STEAM ENGINES REPRESENT THREE-QUARTERS OF THE INSTALLED HORSEPOWER IN ILLINOIS INDUSTRIES

Average engine unit is 118 hp., steam turbine 430 hp., internal-combustion engine 31 hp., and waterwheel 87 hp. Waterwheels are practically absent, representing less than 1 per cent of the installed prime movers.

Valves for pressures of 1,500 to 2,000 lb. at high temperatures present many difficulties to the builders. It is probable that new principles may be employed for such conditions which are not now used at lower pressures. Pipe lines of this kind may not be built much over 4 in. in diameter, from the present outlook.

Alloy steel and heat-treated steel bolts are found in many cases to be less desirable for high-pressure fittings than bolts of machine steel.

Reminiscences of a Veteran Mechanical Engineer—III

First Meeting with James H. Blessing, Inventor of the Steam Loop and Return Trap

The two preceding chapters, in which Mr. Odell relates some interesting episodes connected with William Wright and Henry R. Worthington, appeared in the June 19 and 26 issues. In this week's article he tells of an interesting lawsuit connected with the "steam loop" invented by James H. Blessing. The next number will bring us in touch with one of the tests made on the George H. Corliss "high-service pump" at the Hope Station, Providence, R. I., and it throws a side light on that celebrated controversy.

DURING the fall of 1872 I determined to exhibit at the annual fair of the American Institute, a bucket plunger steam pump in which I was financially interested. Space was secured and the pump all properly connected up, when I was offered a position to take charge at a similar fair to be held in Brooklyn, N. Y. As the Brooklyn fair opened only afternoon and evening, it gave me an opportunity to call at the New York fair each morning on my way to Brooklyn.

One morning as I reached my space in the American Institute Fair, I found the pump in motion and the space nicely cleaned up, with the literature neatly arranged, etc. While wondering if I were awake, or what had happened, Mr. Blessing stepped up and introduced himself, saying my pump was such a nice looking little thing that he wanted to see it in motion and had taken the liberty of starting it up and looking after it.

He was not asked to "show his union card," and thus was started another acquaintance and friendship that lasted many years.

Mr. Blessing then showed me his exhibit of a return steam trap and explained to me the wonderful mystery of its operation. The friendship so strangely started grew with the years, each helping the other when perplexing difficulties developed.

Some years later there was much discussion in the technical press about the "steam loop," its invention, etc., and I advised, as did others, that he write and publish such facts as he had given me and let the engineering profession be the judge as to whom belonged the credit for the invention of the steam loop and return trap. This was done, and I am at liberty to quote from that paper.

In 1868 Mr. Blessing was employed as superintendent of the Townsend Furnace & Machine Co., of Albany, N. Y., a concern established in 1813, the proprietors of which in 1868 were Franklyn Townsend and George F. Jackson, who conducted the works under the firm name of Townsend & Jackson. The plant was then in a part of the city about 150 feet above high tide in the Hudson River. The buildings were all heated by steam, the apparatus for that purpose having been installed by Joseph Nason, a well-known heating and ventilating engineer, about 1856. The offices were heated by direct steam, the water of condensation returned to the boiler by gravity. The machine and pattern shops were heated by exhaust steam when the engine was running, the water of condensation being wasted through non-return steam traps, and by the way, there are many steam plants operated on the same wasteful principle today, unfortunately.

JAMES H. BLESSING

During the year 1870 the proprietor of the Townsend works concluded to move the establishment down to the river front. As the area of the new works was to be much greater than the old one, it necessitated numerous changes in the heating system. It was arranged to use the exhaust steam for heating the foundry and a part of the upper floors, and to heat the offices, machine and pattern shops with direct steam from a boiler to be specially installed for that purpose. Later on it was discovered that it would be impractical to set the boiler low enough to have the water return from the lower floors by gravity, owing to the fact that each tide caused the level of the water in the river to rise higher than the firebox of the boiler.

Then Mr. Blessing in his paper goes on to say:

After having discovered the character of the problem that confronted me, my first thought was to secure a trap that would return the water of condensation to the boiler without the aid of pumps. After making a thorough inquiry, I failed to learn of any such device.

In an effort to solve the problem presented, my mind turned naturally to the thought of returning the water of condensation to the boiler by gravity, and my first experiments were all in that direction. My first return steam traps, invented during the year 1871, were placed above the water level in the boiler, the steam being taken from the steam space of the boiler and acting upon the upper side of a diaphragm contained within the trap and intended for equalizing the pressures. This diaphragm acted simply as a dividing wall between the water on the one side and the steam on the other. The steam used for each discharge of water from the trap was, as in the case of a steam pump, exhausted to the atmosphere. Although the diaphragm trap was successful in its operation, it failed to return all the water and did not make up for the error I had made.

In my experiments with the diaphragm trap several interesting facts came to light. Among other things I discovered that the inlet pipe for conveying the water of condensation to the trap receiver from the coils contained steam and water, for, after the first condensation, due to the extra amount of steam condensed when steam was first let into the heating apparatus, was worked off by a few rapid discharges of the trap, it would require several minutes to collect water enough to fill the trap again. While this was filling up, one could hear the inlet check-valve on the inlet pipe rattling on its seat, caused by the water and steam passing through it. As a result of this observation and the experiments I had been making, it occurred to me that, after all, the coils and radiators were only a part of the direct steam pipe that conveyed the steam from the boiler through them and finally terminated in the small pipes used for collecting the water of condensation.

If this smaller return pipe were connected, so I reasoned, to the top of a vessel of proper size placed a certain distance above the water level of the boiler, the water and steam would pass over into such receiver, the water falling to the bottom and separating itself from the steam. The

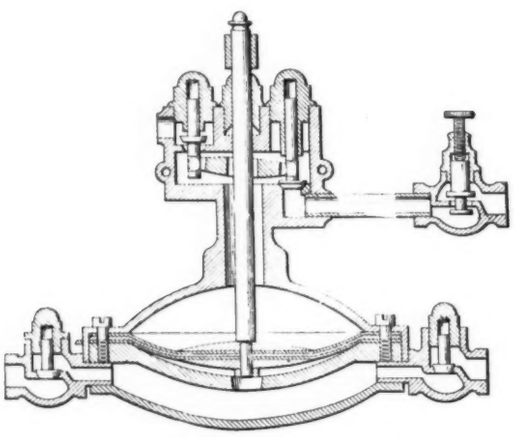


FIG. 1—DIAPHRAGM TRAP

steam pressure in the receiving vessel would be about the same as the pressure in the system at its farthest point from the boiler. If this pressure were near enough to that in the boiler and the receiver were placed at a height sufficiently above the water level in the boiler so that the solid water column would make up for the difference in the pressure, the water would gravitate back into the boiler through a return pipe extending from the bottom of the receiver. With this understanding of the conditions, I prepared a spherical vessel twelve inches in diameter as the receiver to be used in the system with which I was experimenting. I believed that a receiver of the size mentioned would be ample for the purpose, as the capacity was less than one gallon per minute. The receiver was placed on the floor above the boiler where the coils were situated and about nine feet above the water level in the boiler. After the receiver was connected up and steam turned on and the first water and air removed by blowing to the atmosphere, circulation began and was perfectly maintained. This, I believe, was the first steam loop ever made to return the water of condensation from a steam system situated below the water level of the boiler whence the water issued in the form of steam, all without in any way opening to the atmosphere.

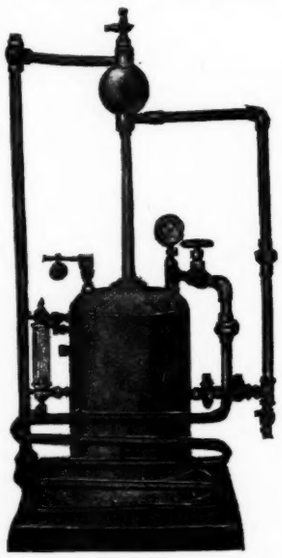


FIG. 2—COURT MODEL

After the steam loop had been in successful operation for some time in the Townsend & Jackson works I thought I would test it in another place. Accordingly, I selected the plant of Messrs. Weed & Parsons, printers, of Albany, where a modern heating system, using steam direct from the boiler, had just been installed. On investigation I found a place about ten feet above the water level in the boiler where the receiver could be placed. After getting the system connected up and making several attempts to start a circulation, I met only with failure. I next concluded to try the steam pressures and found a difference of about eight pounds between that of the boiler and the coils. This explained to me the reason for the failure to get up a circulation, for it would require for the height of the return column of water about twenty-four feet, or over twice the space available. Owing to the conditions under which the system was installed, I could not get a place sufficiently high for the receiver and could not without great expense enlarge the main steam supply pipe so as to make the pressures more nearly equal. I then made a change by taking the receiver and suspending it on one end of a counterbalanced level and added a steam valve for admitting steam direct from the boiler into the top of the receiver for the purpose of equalizing the pressure with that in the boiler. This steam valve was caused to open and close automatically by the rising and falling of the receiver. In this form the trap was known as the Albany Gravity Return Steam Trap.

On this device I received letters patent, dated Feb. 13, 1872; reissued, Aug. 26, 1873. The first claim in the reissued patent fully covers the device known as the "steam loop."

This was the return steam trap first exhibited at the American Institute Fair in New York City during the fall of 1872, where Mr. Blessing and the writer first became acquainted, and it is worth while to note how the inventor progressed from step to step as given in his own words. First the matter of the valve in the inlet pipe. What lesson did that convey? Then when the diaphragm trap proved unsatisfactory, the reasoning process by which the receiver was taken from the vertical water leg and placed on the end of a horizontal pipe, and our old friend steam called on to do something old Mr. Gravity was unable to do under the circumstances. Surely, this is a lesson the young engineer who wants to get somewhere should take to heart.

It was only a short time before suits for infringement were instituted in the United States Circuit Court, Second Circuit, Southern District of New York. The first of these was brought against Baker, Smith & Co., of New York City, who employed as attorney George

Gifford, at that time credited as being one of the most celebrated patent lawyers in the country. Mr. Gifford had as an assistant in the conduct of the case, Edward S. Renwick, a celebrated mechanical expert. Notwithstanding a very able defense, the plaintiff's counsel, Dickerson & Dickerson, of New York, succeeded in obtaining an injunction against the defendants and subsequently against a number of other defendants. As this suit was of country wide interest, we will describe it in Mr. Blessings' own words:

In the first suit against Baker, Smith & Co. it was asserted by the defendant that the first claim in my reissued patent invalidated the patent owing to the fact that the claim asserted an impossibility and that the water of condensation in coils located below the water level in the boiler could not be returned to the same boiler whence it issued in the form of steam, by the device as shown and described in the first claim of the patent issued to James H. Blessing, Feb. 13,

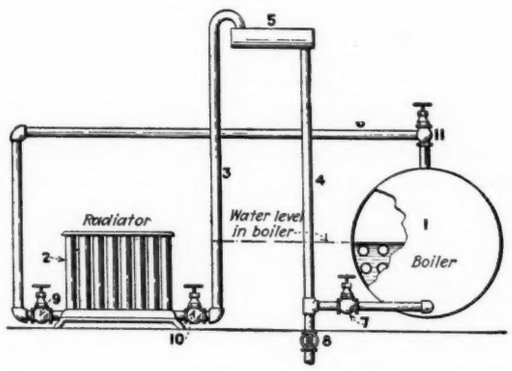


FIG. 3—STEAM LOOP

1872; reissued, Aug. 26, 1873. After the expert, Mr. Renwick, had been engaged for several days giving his testimony in the case and was being cross-examined by Mr. Dickerson in relation to this claim, it was agreed that an adjournment should be taken to give the Albany Steam Trap Co. time in which to produce in court a working model made in accordance with the first claim in the reissued patent. The cut shown in Fig. 2 was taken from this model produced in court during the action against Baker, Smith & Co., the only difference between the court model and the representation in the cut being that the receiving pipe and discharging pipe in the court model were of glass so that the water and steam could be clearly seen as they made their way into the receiver. The glass pipes in the court model became broken and were replaced later with iron ones. With this exception the court model and the representation in the cut are the same. The model still remains the property of the Albany Steam Trap Co. and may be seen at any time by anyone.

After the taking of testimony was resumed, the model was set up in court. Mr. Renwick was asked to examine it and he pronounced it in all respects to be constructed in accordance with the description set forth in the first claim of the reissued patent. After Mr. Renwick's statement in the presence of the court, steam was generated in the boiler by means of a gas burner and when the pressure reached five pounds the steam was let into the coil, the small air-valve on the top of the spherical receiver was opened to allow the escape of air and then closed. It was found that the circulation had commenced and it continued for several hours, during which time the boiler pressure was made to vary from one to fifteen pounds in order fully to test the circulation. The test showed no variation in the circulation, which continued uninterrupted through all the variations in the steam pressure. After this practical demonstration in court the litigation with Baker, Smith & Co. virtually ended.

As Fig. 3 will describe in detail the operation of the steam loop, it is not necessary to do so in connection with Fig. 2, but it will be noticed the 1890 design of loop is practically the same as that of 1870.

Some of the steam loops that have been in use were constructed similar to the sketch here shown. This style of steam loop was brought to the attention of the public about 1890. In the loop shown in the cut it is not necessary to use a receiver to contain the water from many radiators, as there is only one shown.

Referring to the cut: 1 is the boiler, 2 the radiator, 3 the drop pipe from the radiator, 4 the return leg, 5 a short piece of pipe larger than the receiving or discharging leg, which forms the receiver, or separator, 6 is the main steam pipe for supplying the system, 7 is a check-valve opening toward the boiler to prevent the water returning to the system, 8 and 9 are hand valves used on occasions that will be explained later.

To start the loop in operation with steam in the boiler, we first open steam hand-valve 9 to admit steam into the radiator, then open steam hand-valve 8 that opens to the atmosphere, and the steam entering the radiator will displace the air and water from the radiator up through the drip pipe 3 into the top side of the large pipe 5, and so on down through the discharging leg 4 that leads from the bottom of the large pipe 5 and so on through the hand-valve 8 to the atmosphere. When the air and first water have been removed from the system, close the hand-valve 8, and after the discharging leg of the loop has become nearly full of the water of condensation, the circulation will continue through the check-valve 7 into the boiler. This circulation will continue so long as there is no air or an unusual flood of water, for when this happens, pipe 3 will fill solid with water. Under these conditions pipes 3 and 4 (the two legs of the loop) are equal, one balancing the other, and the circulation stops until the equilibrium is displaced by blowing through, as has been before described.

As Mr. Blessing was much nearer my age than other old-time engineers with whom I was associated in youth, it was but natural that we should make confidants of each other, and I wish it were permissible to refer to other discoveries and developments in which we were mutually interested, and which were nearly as epoch making as the advent of the steam loop and return trap.

The Albany Steam Trap as now manufactured is so well known that it does not seem worth while to say more about that, except to note how in each subsequent change the design of the receiving bowl as first used in the steam loop has been crowded out. It has often been noticed that machines have character. Only a few days ago I was in a factory and noticed an idle machine such as I had never seen before and do not even now know what it is used for, but there was a familiar look about it and on examining the name plate, I read "Eickemyer & Osterheld, Yonkers, N. Y."

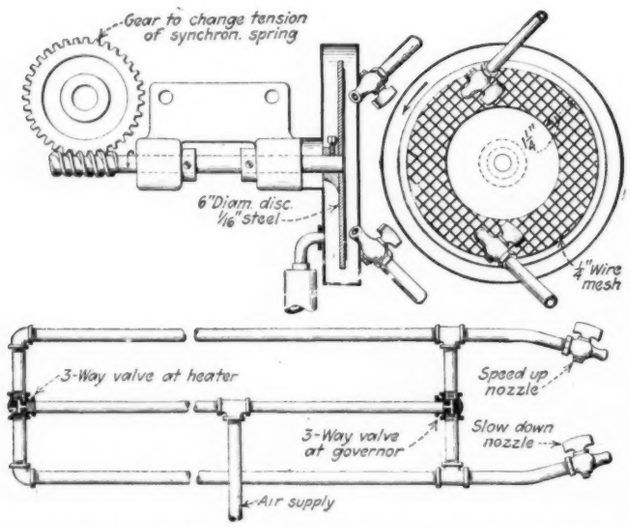
As a final tribute to Mr. Blessing's character, it may be said: Later on in life he was elected as Mayor of the City of Albany and the election returns showed that many voters had evidently dropped their political preferences to vote for a real man; and may I venture further to say, I think this is as it should be in a country like ours.

Sometimes, though rarely, an oily deposit will be found on the outside surface of condenser tubes. This may be removed by pumping kerosene into the first stage of the turbine (through the first-stage gage connection) and pumping the condensate overboard. This procedure should be continued until the condensate is seen to be clear, when it will be found that the outside tube surfaces are clean. The use of kerosene in this manner will also tend to remove dirt and scale from the blading.

Air Turbine Adjusts the Synchronizing Spring of a Steam-Turbine Governor

By Charles E. Colborn*

The load on the house turbine was regulated from the control room in the usual manner, for the purpose of maintaining the proper temperature of the feed water, which was heated by exhaust steam from the house turbine. Conditions arose which made hand regulation of the turbine load at times desirable, independent of the electrical control. It was found somewhat inconvenient to adjust the synchronizing spring tension by hand, on account of the time involved, and a better plan suggested itself. An air-driven turbine was easily rigged up for changing the tension of the governor synchronizing spring on the house turbine. This replaced



PET-COCK AIR NOZZLE AND WIRE MESH ARE EASILY UTILIZED FOR MAKING AN AIR-DRIVEN TURBINE

the hand adjusting wheel and made it convenient to regulate the load either at the heater itself or at the turbine.

The turbine shown in the figure consisted essentially of a $\frac{1}{16}$-in. steel disk, 6 in. in diameter, to which was brazed an annular ring of $\frac{1}{4}$-in. wire mesh. Air was projected against this wire mesh from nozzles, which were constructed of $\frac{1}{4}$-in. pet cocks. The disk could readily be turned in either direction, depending on which nozzle was used. The shaft from this disk was connected by a worm, to a large gear, which changed the tension of the governor synchronizing spring.

The speed and power of the disk depended a great deal on the size and width of the screen mesh, on which the air was discharged. A ring of wire screen $1\frac{1}{4}$ in. wide was found to give good results. An air pressure of 80 lb. in the supply line produced first-class operation. A cover was designed to inclose the air turbine, but this was not installed, as the noise of the exhaust was not objectionable.

In the piping diagram in the figure, it will be seen that one three-way valve was placed in the heater, by which the turbine speed, and therefore the load could be varied at the will of the operator. Another three-way valve was placed close to the governor of the turbine, so that a similar adjustment, for either raising or lowering the speed, could be made at the turbine if desired.

Plans for an automatic air device for adjustment of the feed-water temperature were worked out, including a thermostat for controlling the operation of the synchronizing motor. Up to the present time, however, the hand method has proved amply satisfactory.

*Turbine operator, West Penn Power Co.

The Cooling of Semi-Diesel Engines

By R. E. Dean

Perhaps no item enters into the successful operation of the semi-Diesel engine so much as that of temperature control of jacket water. Yet it appears that this is seldom sufficiently provided for in the average installation.

Not only is it essential that the water supply be ample to take care of the cooling during the warmest weather that the engine may be operated, but a means of rapid control should be provided if the engine is expected to operate efficiently. An emergency supply should always be provided for, so that in case of failure of the main supply there will be no possibility of the cylinder jacket becoming dry.

In city installations the problem of cooling is easily taken care of, provided the engine is within the bounds of the public water system and a little thought is given to the subject of cooling when the engine is being installed. However, the city water pressure should not be depended on for circulation, but rather as the emergency supply.

A centrifugal pump and cooling tower with catch basin should be provided as the normal source of circulation supply. The cooling tower should be large enough to give ample cooling surface and should be constructed so as to spread the water into a thin sheet or film. Wire cloth of about $\frac{1}{4}$-in. mesh is excellent material to use in the construction of small cooling towers. It is applied to the sides of the framework and the water allowed to flow over its surface from a tank at the top of the tower. This tank should be placed at least one foot above the highest point on the engine. The pipe coming from the engine should enter this tank at the bottom and the tank be made to overflow to the surface of the screen. In localities where high winds prevail, the cooling tower may be surrounded by a system of louvers to minimize spray losses.

The centrifugal pump should be placed below the level of the water in the catch basin, should be driven independently of the engine when possible, and should be of ample size to supply the cooling demand of the engine at its greatest load in the warmest weather. A stop valve should be provided in the suction line and a check and stop in the discharge line. The city supply, provided it is of sufficient pressure, should be led into the discharge line between the pump and the engine. This is best controlled by a gate valve.

The hot-water line from the engine, in case of a single engine plant, should not be obstructed by any valves or other unnecessary fittings. In case more than one engine discharges to the same cooling tower, it will be necessary to provide valves in both the hot- and cold-water lines near each engine, so that either engine may be shut off from the cooling system for repairs and cleaning.

A vent to the atmosphere should be provided from the highest point on the engine, with its open end not less than five feet above the top of the cooling tower.

New Type H Taylor Stoker

When the American Engineering Co. introduced the Taylor stoker, a fuel-burning rate of 750 lb. of coal per retort per hour met practically all requirements of the central station and industrial fields, and in fact this capacity was frequently greater than the prevailing practice at that time required; but the provision of greater draft at the boiler breeching in recent years has made it possible to use boilers having more rows of tubes in height in proportion to their width and in some cases boilers with smaller tubes. There has also been a material increase in the rates at which the heating surfaces are worked.

These factors have resulted in the present-day requirements of much higher fuel-burning rates per unit width of furnace, as well as the necessity of a much flatter performance curve throughout the range of operation.

To meet these requirements and at the same time to give a flexibility of application to all types of boilers, the type H stoker has been developed. It can be built in fuel-burning rates from 750 to in excess of 3,000 lb. of coal per retort per hour, and in nine different furnace lengths.

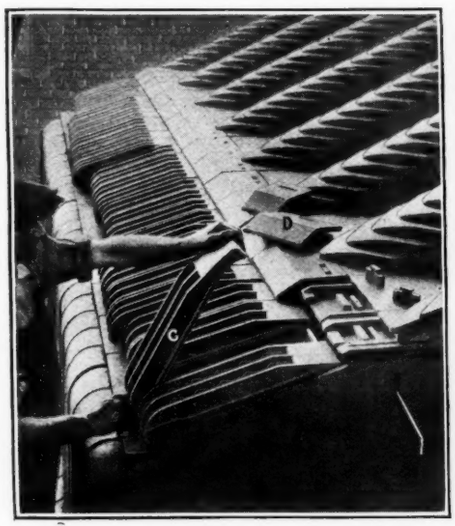


FIG. 1—EXTENSION GRATES AND DEAD PLATES ARE READILY RENEWED

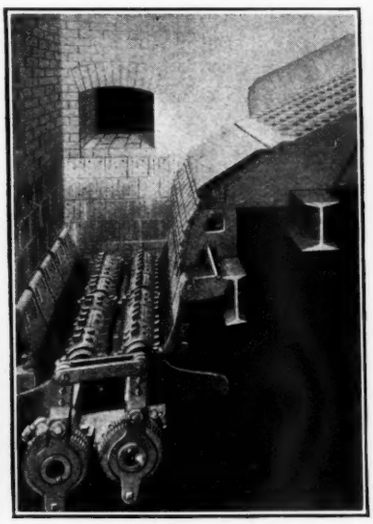


FIG. 2—ARRANGEMENT OF DOUBLE-ROLL ASH DISCHARGE

FIG. 3—STRAIGHT HOPPER SIDES TEND TO ELIMINATE ARCHING OF COAL

The stationary tuyere structure is retained and the use of a variable feed in the lower portion of the retort is taken care of by a series of auxiliary pushers which form the bottom of the retort.

The auxiliary pushers are driven from the feeding plunger by means of one rod with one adjustment for each retort. These pushers are telescoping in action inside of the furnace, and their relative stroke one to the other can be adjusted so as to feed to each part of the retort all the fuel that can be properly burned at that point with the amount of air supplied to it. This design of pusher is intended to eliminate the sticking that has existed in secondary pushers heretofore and also to give a graduated feed throughout the entire retort.

With the dump-plate type of ash discharge a reciprocating extension grate is used which admits air at low pressure to the lower portion of the fuel bed to burn out the remaining carbon. With the rotary ash-discharge type a similar admission of air is obtained through a stationary curved plate leading to the clinker rolls.

Each retort is independently supported by a heavy cast-iron strut which transfers the loading to floor beams. This construction renders the stoker independent of the boiler steelwork and makes it possible to carry a 24-in. front wall of any height.

The ram box is cast solid with no slots. This permits reducing the allowable clearance between the feeding plunger and the ram box to much less than that necessary with former designs.

The stoker hopper is designed with the sides of the hopper throat as nearly straight as possible (see Fig. 3). This practically eliminates the tendency of wet coal to arch. A small gate is placed in the front of the hopper over each ram, providing easy access in case of any obstruction in the hopper.

The feeding plunger has no slots. On its outer end is carried a flange which drives the secondary feeding mechanism. In this plunger is a collapsible (see Fig. 4) toggle which can be adjusted to release at any desired pressure. This eliminates the use of shearing pins or other devices for protecting the feeding mechanism from obstructions in the fuel. It is so designed that the toggle will automatically reset on each inward stroke, and if the obstruction remains in place a small quantity of coal will be continuously fed, which will tend to remove the obstruction.

The stoker is built for operation either by the conventional crankshaft drive through gear reduction boxes or by means of hydraulic cylinders. For the operation of the hydraulic stoker the Hele-Shaw pump is supplied. This pump is of the variable-delivery reversible discharge type and is driven by a constant-speed motor, the speed of the stoker rams being controlled by variation of the stroke of the pump. Reversal of the pump discharge, and consequently of the stroke of the stoker rams, is controlled automatically by the pressure in the system.

For the type H stoker a new drive has been developed. It consists of all-machine-cut spur gearing, and this has made a substantial increase in the mechanical efficiency. All thrust washers, collars and thrust bearings are

omitted as well as stuffing boxes. The stoker speed shaft drives through a primary planetary gear reduction. By means of this a 50 per cent variation in transmission ratio is obtained with all gears constantly in mesh, eliminating shifting of gears or clutches. By providing a neutral point, it is possible to drive directly

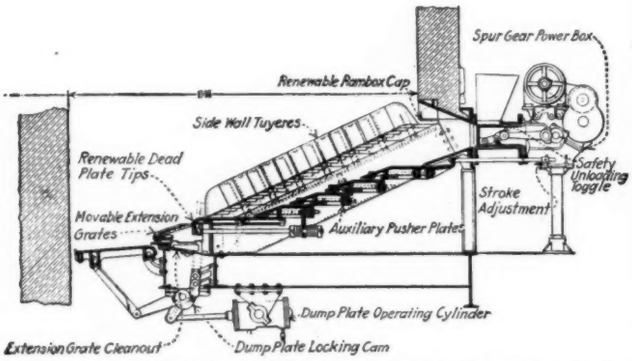


FIG. 4—STOKER IS DRIVEN BY NEW-TYPE SPUR-GEAR DRIVE AND ARRANGED FOR MOUNTING MOTOR DIRECTLY ON TOP OF GEAR BOX

through the boxes where more than one box is used, doing away with clutches and auxiliary shafts. To further reduce friction, universal couplings are installed in the speed shaft connecting two or more gear boxes. The box is designed to mount a motor directly on it, thus making it possible to remove all drive material from the floor if desired, as shown in Fig. 4. A shearing pin is provided in an accessible location next to the final drive.

The tuyeres are cast in blocks and are individually mounted, permitting the removal of any one at any point in the stack independently of the ones above and below it.

The extension grate bars *C* and dead plates *D* can easily be removed, as shown in Fig. 1. The ram-box caps have renewable tips *B* as shown in Fig. 3.

In designing this stoker, special attention has been given to reducing to a minimum the stock of spare parts that must be carried. The only right- and left-hand sections used are the side tuyeres. All dump-plate and extension-grate sections are interchangeable. Only two types of crankshaft sections are used.

When the stoker is equipped with the steam-operated dumping plate, a single-leaf plate is used, giving the maximum ash-discharge area when the plate is dropped. The plate is arranged to swing above the horizontal to clear the bridge wall of any clinker in the same manner as in the present type of Taylor power dump. The plate is supported in operating position by a locking cam on the stoker structure proper, thereby obviating the necessity for any supports in the bridge wall. It is operated by a steam cylinder controlled by a simple three-way valve placed on an operating plate secured to the boiler side wall.

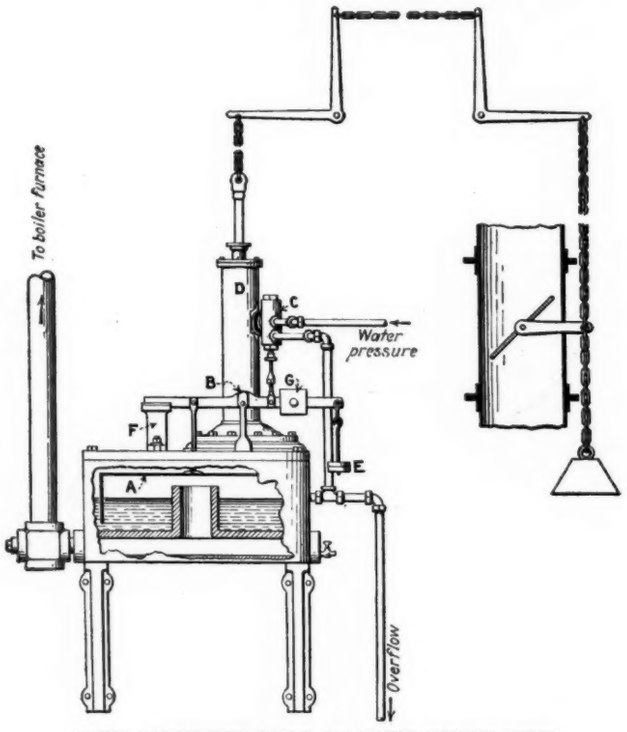
A typical arrangement of the stoker with a double-roll ash discharge is shown in Fig. 2.

Scale formation, blow-down losses and foaming are all detrimental to efficient boiler operation and can be eliminated to a large degree by supplying pure feedwater makeup. Where boilers are operated at high ratings, it is absolutely essential that they be kept clean if burned tubes or more serious results are to be avoided.

The "FE-EL" Furnace Pressure Governor

A damper regulator of the inverted-bell type, manipulated by variations in furnace pressure, controlling the action of a hydraulic cylinder, is now being made under license of the General Electric Co., by the Fessenden-Ellis Co., of Fond du Lac, Wis. Referring to the illustration, there is attached to the balanced scale beam the inverted bell *A*, suspended in water maintained at a constant level in a chamber connected to the boiler furnace. On the opposite side of the fulcrum *B* is the floating stem of a pilot valve *C* which admits water pressure to either end of the hydraulic cylinder *D* and allows the water on the opposite side of the piston to drain through the bell chamber to the overflow. The position of the piston in the hydraulic cylinder controls the position of the breeching damper and may regulate also the fan and stoker drives.

The scale weights *E*, suspended at one end of the beam, balance the moving parts. A compensating spring at *F*, at the opposite end of the beam, is provided to dampen any tendency toward hunting or pulsation.



NEW INVERTED-BELL DAMPER REGULATOR

The sliding weight *G* on the beam may be set for the furnace pressure it is desired to maintain. Because of the large area of the floating bell, the regulator is sensitive and in practice is reported to maintain the pressure in the furnace uniform within 0.02 in. of water pressure.

Wire rope must not be handled like hemp rope, and kinks or near kinks must be strictly avoided. In installing ropes that come in coils, the rope should be stretched full length on the ground by unrolling the coil like a wheel. Before cutting a cable, it must be tightly bound with a number of turns of iron binding wire on each side of the proposed cut, to avoid the "unlaying" of the strands and the attendant "high strands" while in operation.

EDITORIALS

F. R. LOW, EDITOR

The Elements of Power-Plant Efficiency

THE fundamental requirements for power-plant efficiency may be reduced to five items, as follows: Maximum boiler-plant efficiency, including ecomomizers but excluding (for the moment) power-consuming auxiliaries; production of power with the maximum thermal efficiency by that major portion of the steam which is expanded to the main condenser pressure; minimum loss through the leakage of steam and hot water and radiation from piping, etc.; minimum power consumption by the auxiliaries; maximum production of low-cost power as part of the feed-water-heating process.

The average engineer probably has a clearer conception of the importance of the first three items—boiler efficiency, main unit efficiency and cutting down leaks—than he has of the fourth and fifth. The fourth item —"minimum power consumption by the auxiliaries"—has only of late begun to receive the attention it deserves. As long as they perform their work effectively, the less electric power or steam the auxiliaries consume, the better will be the over-all efficiency of the plant. The fact that the exhaust of steam-driven auxiliaries, or the exhaust of a house turbine furnishing power to electrically driven auxiliaries, is used for feed-water heating, does not affect the truth of this statement.

This is made clearer by a study of the fifth item, which reads: "Maximum production of low-cost power as part of the feed-water-heating process." This is the primary object of "heat balance," a live subject just now in those plants where other possible sources of saving have been pretty well exhausted, as far as present commercial possibilities go. In dealing with this subject, some engineers have been confused by the fact that power taken from steam later used for feed-water heating is obtained at a cost of only 4,000 B.t.u. per kilowatt-hour (or 3,000 B.t.u. per horsepower-hour), this rate being practically independent of the steam rate of the engine or turbine or bleeder turbines. Steam economy here pays dividends, not by reducing the heat cost per unit of power generated from feed-heating steam, but rather by increasing the amount of power that can be so generated.

Thus, by increasing the percentage of this cheap power, the average heat consumption per unit of total plant output is decreased. Other things being equal, the more power obtained from feed-heating steam the more efficient will be the plant. While the highest plant efficiency is obtained by driving all auxiliaries electrically from the main unit, which in turn is bled for heating the feed water, this has not yet become common practice. In most plants some, and in many plants all of the auxiliaries are steam driven. In such cases the use of efficient steam engines or turbines for auxiliary drive will give just that much more opportunity for the main unit to produce cheap power from the feed-heating steam.

The "Leviathan"

NO COUNTRY can be great with a world's greatness without a merchant marine. No country can maintain a great merchant marine without passenger traffic. To wrest the passenger traffic from lines that have a prestige founded upon years of successful operation, a clientele attached by habitude, vogue and pleasant association, it is necessary that one offers something superlatively better.

Hence the "Leviathan."

She was built in 1913 at the Blohn & Voss yards at Hamburg for the Hamburg American line and christened the "Vaterland." When she was seized by the United States on April 6, 1917, as she lay at her dock in Hoboken, her machinery was found to have been badly mutilated. It was repaired by electric welding under the direction of Captain E. P. Jessup, U. S. N., in a fraction of the time that new parts could have been supplied, and during the war she transported 96,804 officers and men to Europe in ten trips, returning 93,746 after the armistice.

The United States Shipping Board determined to convert her into the most comfortable, sumptuous, safe and rapid large passenger vessel afloat and to make with her a bid for the transatlantic passenger traffic. The contract for reconditioning her was awarded to the Newport News Shipbuilding and Dry Dock Company, the plans being prepared and the work supervised for the Shipping Board by Gibbs Brothers, Inc., of New York. The Newport contract price was $6,100,000 and the Gimbel Brothers were awarded the contract for the furnishings, the total being $8,200,000. Both contracts were carried out in every detail to the satisfaction of the Board, but with a loss to the Newport News Company of $1,200,000.

The keynote in all this project has been safety. The boiler department is divided into a large number of units, each of which has four hose lines, discharging Foamite, and should a fire in any compartment get beyond control it can be instantly isolated and flooded. Each stateroom and compartment where a fire might start is provided with an indicator which, upon a sudden rise of only a few degrees in temperature, will flash an alarm to the bridge and indicate its location. The hull is divided into numerous water-tight compartments, many of which could be flooded without sinking the ship. The old coal bunkers form blister tanks closed on the inside so that the penetration of the outer skin at those points would not admit water beyond the inner wall. The electric work has been completely renewed in accordance with the latest safety codes. Two Diesel-engine-driven electric-light units are installed high above the water-line to furnish light should the main plant become flooded. No expense or pains have been spared to forestall any preventable mishap.

The "Leviathan" in 950 feet in length. The "Majestic," built as the "Bismarck," on the same lines as the "Vaterland," had two meters added to her length to

make her the longest vessel in the world. The "Leviathan" has 46 Scotch marine boilers, each of which can burn about a long ton of oil per hour at maximum capacity. There are four propellers, with turbines rated at about 60,000 horsepower at normal capacity and capable of forcing to 100,000 horsepower or more. Details of the power plant are promised for an early issue.

It was necessary, before putting such a ship into commission, to give her a thorough trial under seagoing conditions, and those in charge considered it, if not as essential, at least desirable that the personnel of the boat, stewards, culinary department, etc., should have a chance to accustom themselves to the boat and organize their service under the conditions of an actual passage. Accordingly, some 400 guests were invited to supply the passenger list. It was a wise provision, for notwithstanding the service as a whole went very smoothly, a number of little oversights developed under the conditions of actual use, and opportunity was afforded for daily fire drills, boat drills and the handling of signals and passengers under such emergencies.

The "Leviathan," which had been in dry dock at Boston, left her moorings at 3:20 p. m. on Tuesday, June 19. There was a dense fog throughout the night and at noon of the 20th she had made 300 miles at an average speed of 14.6 knots. She proceeded south to the Bahamas, passed through Providence Channel the night of the 21st and at 7:17 on the morning of the 22d was off Jupiter Light on the Florida Coast. With fine clear weather and a smooth sea she followed the regular northbound steamship track to Diamond Shoal, arriving there at 3:39 a.m. Saturday, June 23, a distance of 570 miles, which she covered at an average speed of 27.99 knots. From Jupiter Light to 36.52 N. lon. 74.21 W. lat., a distance of 687 miles was made in 25 hours, making an average speed of 27.48 knots, beating the record run of the "Mauretania" in January, 1911, of 27.04 knots average for the same length of time. During the first hour of the run from Jupiter Light the average speed was 28.04 knots, and for a six-hour period the average speed was 28 knots. The Gulf Stream was with her, but the 85-degree cooling water for her condensers was a serious disadvantage.

The "Leviathan" carries over 3,200 passengers and 1,100 crew, and is the equivalent, in the most sumptuous of living accommodations, to two of the largest first-class hotels, mounted upon a superpower plant. She will leave New York on her maiden transatlantic trip on July 4 with a full complement of passengers, and it is hoped that she will become the rallying point for the re-establishment of American prestige upon the seas.

No records are to be looked for immediately, but she has large reserve power to maintain her schedule and it is likely that this summer will see some interesting contests upon the North Atlantic.

The Drum-Type Rotor and the Impulse Turbine

CONDITIONS governing the design and manufacture of medium-sized impulse turbines do not indicate that there is any likelihood of utilizing drum-type rotors for some time to come. With large turbines in general, features have recently appeared suggesting that revolutionary developments, or perhaps schemes that now appear inconsistent, may find definite applications eventually. Reaction-type units have recently been described wherein the last row of exhaust blading is to be of the impulse type. As impulse units increase in size, some conditions appear to favor a drum-type rotor for the final stages.

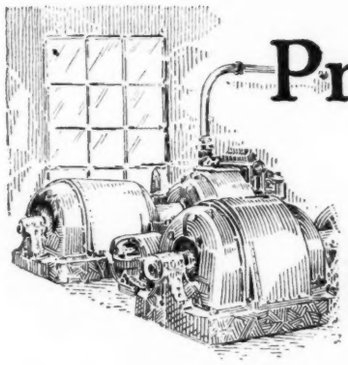
The impulse stage, usually of the two-row Curtis type, is firmly intrenched as the most desirable construction for the first steam expansion at the high-pressure end. Friction losses are comparatively high in turbine disks at such pressures. Leakage around the tips of the reaction blades becomes serious at these correspondingly small volumes. It is therefore regarded as advantageous to expand to a comparatively low pressure as quickly as possible in the first stage, for which a Curtis wheel is particularly fitted. This also has the advantage of producing a shorter rotor, with lower pressures and temperatures, thus relieving to some extent interstage packing and blade material.

Reaction-type vanes, under the most favorable conditions of steam and blade speeds, are in some quarters conceded to operate at efficiencies higher than equivalent commercial impulse stages. They are especially adapted to low-pressure elements where leakage around the blade tips is small in proportion to the steam volume. Nevertheless, impulse units both in this country and abroad have not compared unfavorably with reaction or impulse-reaction type turbines in large sizes, as regards published data on steam consumption. On the other hand, efficiency is only one of several factors governing turbine design. Cost of manufacture may be responsible in fixing the turbine construction.

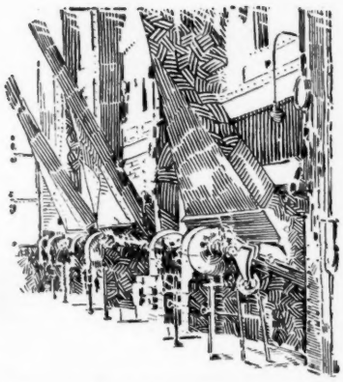
As turbines increase in size, the low-pressure elements eventually must either be arranged as multiple units, as the cross-compound or double-flow, or else must utilize longer vanes or possibly a combination of such expedients. Impulse rotors, as built in practice, inherently contain fewer blade rows than reaction type and therefore may be said to be favored in that respect.

With increasing blade lengths the questions of rigid fastening and the avoidance of a tendency to local vibration become more serious. These matters inherently depend on a comparatively rigid and extensive supporting structure. A disk that is stiffened, approaches a solid cylinder or drum. The substitution of one or several drums or cylinders for disks, where excessive blade lengths are carried, appears as a probable future construction. Blade rigidity has been increased in many instances by widening the blade shank in an axial direction at the root of the blade, tapering to a narrower tip. This permits greater steam passage area between blades, as well. The wider blade root is therefore more suited to a widened disk for fastening and suggests in itself the advantage of a drum- or cylindrical-type rotor, especially where excessively long vanes are to be employed.

Interstage packing, which prevents steam leakage along the shaft, has become regarded almost as identified with impulse construction. In a rotor of large diameter, interstage packing appears to be a more ponderous affair. It must be remembered, however, that the pressure differences between stages in the vacuum region of an impulse rotor are comparatively small, under two pounds per square inch in some instances. Therefore, packing is not such a serious problem. Besides, with very long blades leakage represents a comparatively small proportion of the steam flow. Labyrinth packing appears as a simple expedient. Where impulse types are manufactured, a drum- or cylindrical-type rotor might be regarded as a future possibility for low-pressure elements of large units.



Practical Ideas *from* Practical Men



Correcting the Overloading of Motors Driving Centrifugal Pumps

Most of the problems relating to the correcting of overloading of motors driving centrifugal pumps are more or less technical, and they depend largely upon an intimate knowledge of the pump and its characteristic curve. For this reason, many of the readers of *Power* might be glad to know of a short-cut rule that will apply to troubles of this sort. This rule has one limitation which should always be remembered, and that is that it applies only to pumps whose load is frictional. This includes circulating pumps of all kinds such as for refrigeration, heating or condenser service. The rule can also be used where the load is mostly friction, say 60 per cent or more, but in that case it must be used with more caution, depending upon what proportion of the head consists of friction.

The method involved consists of chucking the impeller in a lathe and turning enough stock off the diameter to keep the load under the normal rating of the motor. The rule is, find the percentage of overload on the motor and divide by 3. The result is the percentage by which the impeller should be reduced. The following example will illustrate:

Load on motor	6 horsepower
Rating of motor	5 horsepower
Overload	20 per cent
Divide by 3	6.7 per cent
Impeller diameter measures	13.00 inches
Reduction = 13 × 0.067	0.87 inches
Resulting diameter	12.13 inches

After turning the diameter to the size calculated, file the tips of the blades to a sharp edge corresponding approximately to that which was on the impeller before turning.

This rule is based on the principle that for frictional loading the power required by a centrifugal pump is proportional to the cube of the diameter. As reducing the diameter by one-third the overload is a slightly less amount than cubing the diameter, and also because it is simpler, it is recommended as a safer rule.

Mt. Clemens, Mich. RUSSELL K. ANNIS.

Grinding Commutators

Is the use of commutator resurfacing stones being carried too far? I believe that such is the case. These stones are useful for cutting down ridges or mica on the face of the commutator, but their success in truing up commutators that have become worn in such a way that they are no longer round, is doubtful. When a commutator becomes worn so that it no longer runs true (is out of round), it should be placed in a lathe and turned true, then surfaced as smooth as possible before being placed back in service.

There are grinders on the market that are intended to true up commutators as well as can be done on a lathe and having the advantage of doing their work without the necessity for removing the armature from the machine. It is not these grinders to which this article refers, but the small stones that are held against the surface of the commutator by hand.

It appears to be the belief of some operating engineers that these hand-operated resurfacing stones are a cure for all commutator ills. This, however, is not the case. In a large percentage of the cases of sparking, the cause lies in the brushes and brush-holders. It may be that the brushes are too large to move freely in the holders or that dirt and grit have become lodged between the brushes and their holders, thus having the same effect as if the brushes were too large. The remedy in both cases should be obvious, and it can readily be seen that the use of any kind of grinding stone will aggravate rather than remove the cause.

The too frequent use of these stones will, in a comparatively short time, wear the commutator down to such an extent that it will need to be rebuilt.

Albert Lea, Minn. K. R. DUNCAN.

A Word About Steam Plants

We occasionally read in the trade papers, articles treating of the economical operation of steam plants and explaining why recording instruments should be read frequently and the readings entered in the log-book. Some engineers lay great stress on the value of routine work about the plant, giving rules for performing the regular duties at specified times, regardless of any extra work that may unexpectedly turn up, all of which is good logic—for the big plant, with plenty of help in the shape of boiler-room foremen, bookkeepers, accountants, etc., and equipped with all the necessary recording instruments, gages, meters and indicators. But what about the "little feller" that is trying to operate a plant of less than 1,000 hp. on a shoe string, so to speak? He will probably be obliged to get along with as little help as possible. He may have a pair of indicators (like enough his own property). He will be lucky if there are a recording steam gage and a voltmeter on the job.

There is no doubt about the advantage of system in any business, but in a small plant, with a limited crew, it is impossible to attain the same degree of efficiency, as in the larger plants.

The first thing to be considered by the engineer is the safety of his crew, others who may be in the vicinity of the plant and the plant itself. Next, the reliability of continuous operation and keeping the plant in a con-

dition to avoid interruptions of production. Lastly, all operating engineers should be interested in the efficiency and economical operation of the plants under their charge.

The apparatus requiring the most attention in the boiler room is, of course, the boiler and its fittings. The safety valves should be of the proper size, and if the outlet is led through the roof, provision must be made for drainage. The blowoff pipe in the back-connection must be protected from the flame. A V-shaped baffle, of firebrick, should be built in front of the pipe. In the absence of that, good results may be obtained by winding the pipe with about three thicknesses of ¾-in. asbestos rope. For blow valves an asbestos-packed cock and a Y-valve make a good combination. It is well to feel the pipe occasionally, outside the valve, to make sure there is no leakage. Boilers should be blown down at least once during each watch, and oftener if the feed water is dirty.

Much discussion has taken place among engineers as to the proper method of connecting a water column to the boiler. A method that I consider one of the best is shown in Fig. 1. In piping for steam gage in a lower location, such as the engine-room gageboard, a correction can be made for the weight of water in the drop leg, by setting the pointer at zero when the pressure is off. All separators, receivers, and wherever steam pipe is changed from one size to another, should be drained and led to suitable traps and the traps kept

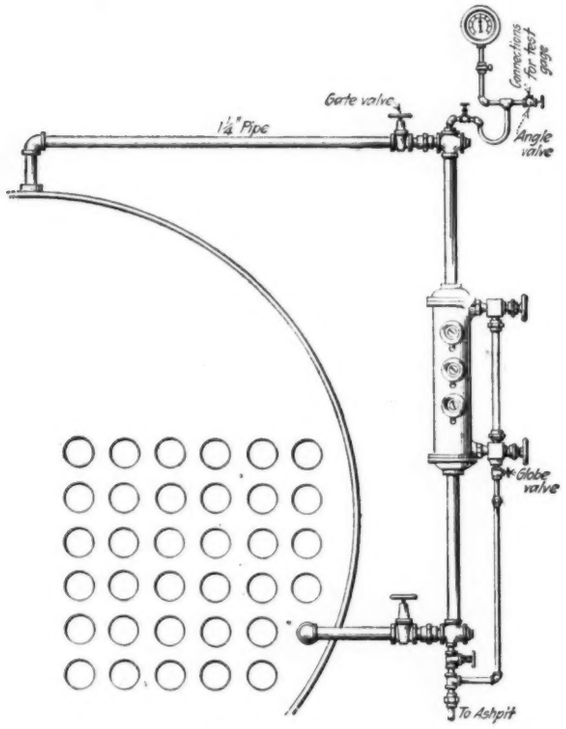


FIG. 1—WATER COLUMN AND STEAM-GAGE CONNECTIONS.

in order. A general arrangement of drains for this purpose is shown in Fig. 2.

Regarding the economical operation of a steam plant a great saving in coal may be made by careful and intelligent firing and the proper handling of the draft. Where automatic damper regulators are installed, firemen are sometimes prone to depend too much upon them. What I mean is, they may not look at the condition of the fire until they see the weights on the regulator move the whole distance. Some will shovel on more coal at a time than is necessary, in order to have a longer rest between firings. If these matters are looked after and regular firing made the rule, better results will be obtained. In fire-tube boilers burning soft coal, the tubes should be blown at least once each watch. With

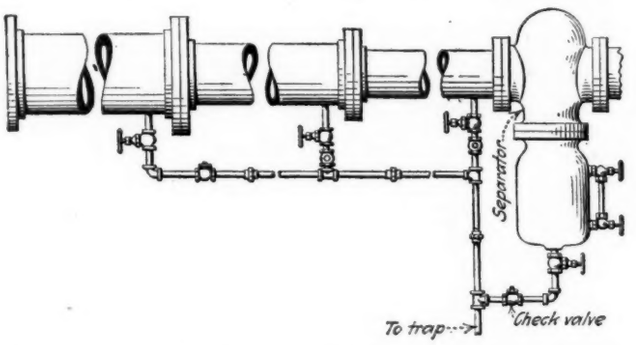


FIG. 2—DRAINS SHOULD BE PROVIDED WHERE CHANGE IS MADE IN SIZE OF PIPE.

good anthracite perhaps two or three times a week will do, depending on the condition of draft. It is good practice to blow the soot from water-tube boilers every day. Keep a constant level of water in the boilers. See that the feed pumps and heater are always in condition and that water is supplied to the boilers as hot as the system is capable of. Look out for leaks. One or two small steam leaks do not appear to amount to much, but a surprising amount of steam is wasted by a few small leaks in a day's run, so let us keep our plants in order.

Camden, Me. M. M. BROWN.

Is Too Much Expected of the Operating Engineer?

The duties of operating engineers are varied and many, and they are often called upon to perform work for which other help should be employed. I have charge of a plant consisting of two 400-kw. Corliss-engine-driven units and four 3,300-sq.ft. water-tube boilers, two of which are fired with oil and two with coal. Formerly, we used the four boilers during the cold weather, but this winter we used only three. The two oil-fired units were kept in active service with one coal-fired boiler banked most of the time.

We have recently experienced considerable trouble from tubes pulling out of the front header and from blistering, so in order to keep the plant running I put in the tubes myself, sometimes coming on the job at night or early Sunday mornings.

Now my job calls for seven days a week, but since overtime is necessary when replacing tubes, I always claimed a full day's pay, whether I put in one tube or five, but my manager thinks I should do this work for nothing. A short time ago I hired a boilermaker to renew eight tubes, and he charged $34 for the job, which is much more than my overtime pay for the same work, as I can replace a tube in an hour, including baffle brick and handhole plates.

Now in my opinion engineers should not be expected to do this work, but a regular mechanic should be employed. I should be glad to hear from some readers on this point. J. G. WATERS.

Springfield, Conn.

Comments from Readers

Why So Many Calculations in the Boiler Test Code?

In the April 10 issue appeared an article by Mr. Brownlie in which he suggests certain changes in the Boiler Test Code of the A.S.M.E. It is not my intention to discuss those suggestions, but it just happened that when that article appeared I was engaged in some work which necessitated a close study of the Code. I discontinued my struggle with the calculations of boiler tests long enough to read Mr. Brownlie's interesting article, and in commenting further on this code, I would like to ask, Why so many calculations?

Let us consider, for example, Item 18, factor for correction for quality of steam; and Item 26, total water evaporated corrected for quality of steam. Of what practical use is it to calculate this hypothetical quantity of dry steam which the boiler *might* have made (but did not) by absorbing the same amount of heat? Not for purposes of comparison with other boilers or other tests, because, for direct comparison, the steam pressures and feed-water temperatures must be the same in both cases. The likelihood of such a fortuitous occurrence is too small to be considered. The result does not appear to be worth the time and trouble needed to obtain it. The same observation applies to Item 38, in which we are expected to divide this quantity of imaginary dry steam by the weight of dry coal fired; and to Item 31, in which we calculate the weight of this fancied steam produced per hour.

Of course the equivalent evaporation from and at 212 deg. is also a hypothetical quantity. But it has the merit of resting on a uniform and definite basis as to feed-water temperature, steam pressure and quality of steam. In order to make direct comparisons, the evaporation, or apparent evaporation, must be corrected for all these three factors. Why correct for only one (the quality) and put four items in the report to record the results. If there is any good reason for this, I fail to see it. Since the apparent evaporation (total water fed to boiler) is to be reduced to equivalent evaporation at 14.7 lb. pressure from feed water at 212 deg., why not make *one* operation of the process and be done with it?

Another question suggests itself. Having figured Items 18 and 26, why not calculate another factor of correction, by means of which we can reduce Item 26 to imaginary evaporation at 14.7 lb. pressure or to imaginary evaporation from feed-water at 212 deg.? Either of these results appears to be as useful as "water evaporated corrected for quality of steam." Since there are three factors to be considered, in converting the actual (apparent) evaporation to equivalent evaporation from and at 212 deg., why not take them one at a time in all of the six possible orders? This is obviously absurd, but is it any more so, except that it involves more work, than to make the correction for quality alone and ignore steam pressure and feed-water temperature?

Now let us go a step farther and consider for a moment the advisability of short-cutting the whole process and abandoning equivalent evaporation from and at 212 deg. entirely. Is it of any real value except as an historic relic? The latent heat of one pound of steam at 212 deg. is 970.4 B.t.u. according to Marks and Davis. This is not far from 1,000 B.t.u. The calculations pertaining to a boiler test would be very much simplified if this figure 1,000 were used as a unit of evaporation instead of the latent heat of steam at 212 deg., which is 970.4 according to Marks and Davis, 971.7 according to Goodenough, and was 965.7 only a few years ago. If the actual evaporation (or heat absorption, which it really is) were converted into thousands of B.t.u., the factor of evaporation would be eliminated. In its place might appear an item such as "Heat absorbed per pound of feed water.....M. B.t.u." A corresponding revision of all the items pertaining to equivalent evaporation would be necessary.

The equivalent evaporation, like the boiler horsepower, will die hard, if it dies at all. But let us see if it really is of as much use as we are accustomed to think. The value we place on it is probably due to habit rather than to any intrinsic virtue of the unit itself. By a "boiler test" is really meant a "boiler-and-furnace test." All through the process we are dealing with *heat*, its generation and absorption. Since we have a perfectly good and generally accepted unit of heat, why not stick to it during the whole calculation of the results? Why pick out an odd number of these units, like 970.4, and use this as a new unit for this particular purpose and for no other? If the B.t.u. is too small for use in connection with boiler tests, it appears to me that it would be more logical, since we use a decimal system of numbers, to adopt some decimal multiple of the B.t.u., as already suggested. But I see no valid, logical reason for doing even that. The heating value of fuel is measured in B.t.u. and so far as I have ever heard no one has suggested that it be measured in a unit of 970.4 B.t.u., or of a thousand, or of any other number of B.t.u.

If we study the question just a little further, we shall see that we very promptly get away from this queer unit of equivalent evaporation from and at 212 deg. and go back to our old friend the British thermal unit. I venture to say that the two most important items in the report are No. 44, efficiency of boiler, furnace and grate; and No. 45, efficiency based on combustible. In order to evaluate these items, we divide the heating value of one pound of the fuel (or of the combustible) expressed in B.t.u., into the heat absorbed from one pound of fuel (or combustible), which *must* be expressed in the same unit. To make the reduction to B.t.u., we multiply equivalent evaporation per pound of fuel (or combustible) by 970.4. In other words, we first divide by 970.4 and then multiply by the same figure. The only apparent benefit from this process is to give the calculator a little practice in arithmetic.

As a matter of fact the entire process is even more roundabout than this. To obtain the factor of correc-

tion for quality of steam (Item 18), we divide the heat absorbed by one pound of feed-water, which we may call h_1, by the heat of one pound of dry steam at boiler pressure calculated above feed-water temperature. Call this h_2. Then

$$\text{Item } 18 = \frac{h_1}{h_2}$$

The factor of evaporation is $\frac{h_2}{970.4}$

In order to obtain total equivalent evaporation from and at 212 deg., it is necessary to multiply water fed to boiler by

$$\frac{h_1}{h_2} \times \frac{h_2}{970.4} = \frac{h_1}{970.4}$$

It should be noticed that h_2 cancels out in this operation. And finally, before calculating the efficiency, we convert the equivalent evaporation back to B.t.u. by multiplying by

$$\frac{h_1}{970.4} \times 970.4 = h_1$$

and we have, water fed to boiler $\times$ h_1, which might as well have been calculated in the first place by one simple multiplication.

Again I ask, "Why so many calculations?

W. E. WINES, Assistant Professor.
Mechanical Engineering.
Madison, Wis. University of Wisconsin.

Investigating Injection Conditions in Oil Engines

In *Power*, May 1, under the title, "Solid-Injection Oil-Engine Investigations," Edvin Lundgren describes a device designed by K. J. E. Hesselman for investigating the interval of injection and the dwell of fuel in the cylinder before combustion occurs. This device was probably used only with engines of large capacity and of moderate speed. A method devised for investing injection conditions for engine speeds up to 1,800 r.p.m. and requiring no special equipment may interest readers of *Power* who are working with solid-injection engines.

It is an old trick, when investigating the characteristics of a fuel jet discharged into the atmosphere, to

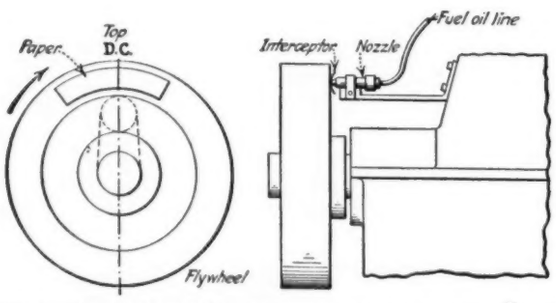


FIG. 1—ARRANGEMENT OF FUEL NOZZLE AND PAPER

hold a piece of paper at different distances from the orifice and observe the pattern on this target. In order to get the following information the idea was carried a little farther. The information desired was: (a) The lag in the start of the jet behind the start of the fuel-pump plunger; (b) the beginning of injection with respect to crank distance from dead center; (c) the interval of injection in terms of degrees of crank travel; (d) the manner in which the spray builds up and dwindles.

At high revolutions per minute it is necessary, when indicators are used, to eliminate the effects of the inertia of indicator parts. Absence of linkages or connections that might distort the diagram is also desirable. Fig. 1 will help explain the set-up and procedure devised to overcome the foregoing effects.

Instead of a special indicator drum, the side of the flywheel rim is used to carry the paper for the diagram.

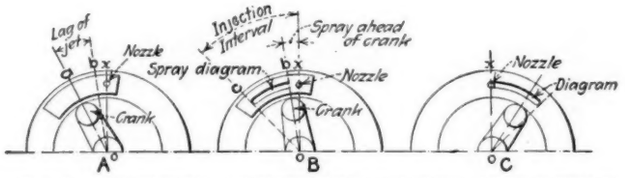


FIG. 2—INJECTION ANGLE SHOWN BY SPRAY DIAGRAM

A piece of paper cut approximately to suit the curvature of the flywheel and somewhat longer in degrees of crank travel than the injection interval, is attached with shellac. Unsized paper, like newsprint, is best, since it is more easily penetrated and cut by the jet. By smearing the exposed side of the paper with dry lampblack a rather good indication of the change in volume of discharge as the nozzle valve opens and closes, is revealed by the width of the pattern. Thus patterns may be obtained such as are sketched in Fig. 2; the pattern depends, of course, on the design of nozzle, type of injection pump, rate of fuel discharge, r.p.m., etc. It is well to mark the ends or limits of a spray diagram with pencil after it is made, since the clearness of the pattern may decrease as the oil dries out.

The procedure is to attach the nozzle to the engine bed so that there is just room to insert a piece of sheet iron between the nozzle orifice and the paper. By inclining the nozzle somewhat so that the jet meets the advancing paper, the paper will suffer the most furring-up, and hence reveal a more definite pattern than when the "shooting" is normal to the paper or tending to follow the movement of the paper. The point where the jet strikes the flywheel should be exactly in the plane of the crank axis at top dead center if corrections are to be avoided in measuring angles. A piece of sheet iron, bent to form a small trough, is held between the orifice and paper so as to intercept the spray till the desired engine speed and pump adjustment are obtained. Then the sheet iron is withdrawn and replaced after such number of discharges as may be necessary to make a definite pattern on the paper.

An interpretation of a spray diagram may be illustrated by Figs. 2*A* and *B*. The vertical line represents top dead center on the engine frame, the nozzle being situated on this line. Position *a* is the location of the crank when the fuel plunger begins its discharge stroke. The crank is at *b*, Fig. 2*B*, when the spray appears. Hence the jet lags behind the start of the plunger by an angle *aox–box*, or equal to *aob*, Fig. 2*A*. With the crank at *b*, Fig. 2*B*, and the spray beginning to register on the paper, the pattern or diagram will begin to show at an angle *xob* ahead of the crank, or while the crank yet lacks an angle *xob* of reaching dead center. As sketched, the discharge continues till the point *c* on the flywheel is passing dead center. Hence the interval of injection is equal to an angle *cox*. Injection occurs for an angle *box*

before the crank passes top dead center and lasts till the crank is an angle *boc* past dead center.

To measure those angles a piece of paper or tracing cloth may be laid off in units of $\frac{1}{360}$ of the circumference of the flywheel, and the distances then read directly in degrees of crank travel. The size and clearness of the pattern give evidence of the rate of fuel discharge during those intervals and also of the increasing or decreasing energy of the jet as the nozzle valve opens and closes.

The available penetrating power of the jet gives some engineers much concern. With large cylinders penetration is necessary to give fuel distribution throughout the combustion chamber; with small cylinders it may land the fuel on relatively cold cylinder walls. With cylinders under 6 in. in diameter it is possible that air turbulence rather than jet penetration is the more vital to fuel economy and flexibility. The necessary proportions of turbulence and penetration, are not, of course, subject to calculation. ROBERTSON MATTHEWS.

Hampton, Va.

What Design of Furnace Is Best for Burning Mill Refuse?

In reply to the request of R. B. McQuiddy, in the May 8 issue, for information on the best design of furnace for burning mill refuse, I offer the following:

From an experience of more than 20 years covering plants in different parts of the country, I consider the Dutch-oven type of furnace superior to all others. I have been ten years in charge of my present plant, in which we convert all our refuse into power, and we have never had to buy current or maintain a destructor.

Figs. 1 and 2 show the general layout of Dutch oven and boiler setting that I have found most satisfactory. The grate surface is 36 sq.ft., and as shown in Fig. 1 the fuel falls on the center of the grate and builds up into a flaming cone. Air for combustion is admitted through the grate around the base of the cone, and considerable air is also drawn through the hopper into the top of the oven by the stack draft. With a moderate and fairly continuous stream of fuel we experience no difficulty in

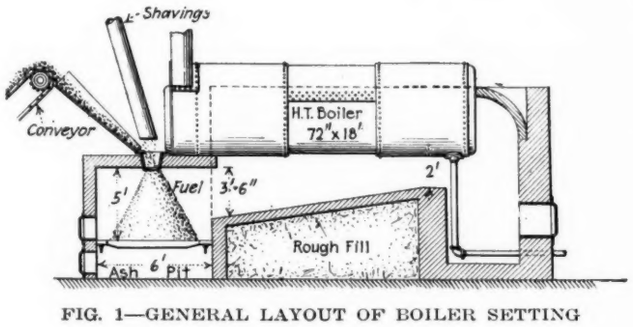


FIG. 1—GENERAL LAYOUT OF BOILER SETTING

maintaining a high furnace temperature, and all kinds of wet and dirty refuse and inferior fuel can be burned to good advantage by hand firing it in reasonable quantities through the front doors. In fact we burn all our yard sweepings in that way and get all the fuel value out of refuse that would be unburnable alone. The boiler tubes remain comparatively free from soot. The rising flames from the cone of fuel strike the roof of the oven and combustion is well completed before reaching the shell of the boiler.

The shavings are best handled by a suction fan which takes them from the different machines and discharges them through a cyclone separator to the hopper of the oven. Small blocks, short cuttings, etc., are generally handled by a conveyor and dropped on a sheet-iron trough which slants steeply down to the hopper. Cull lumber and sticks large enough to handle by hand are best fired through the front doors, which should be reasonably large and meet without any central pier. When more shavings are coming through the blower

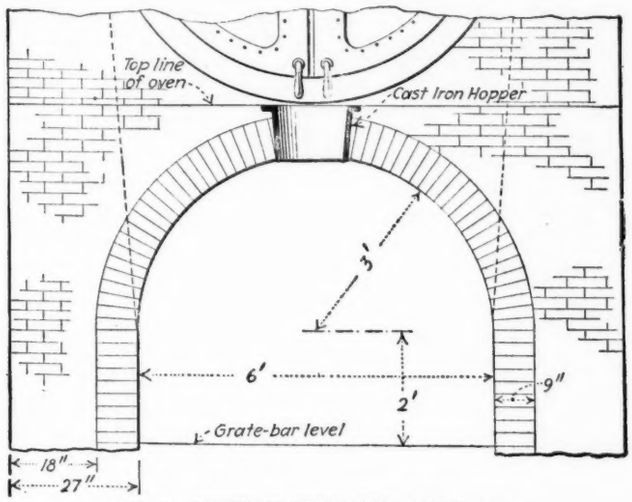


FIG. 2—SECTION THROUGH OVEN OF A 72 BY 18 FT. BOILER

system than are needed, a portion of them can be discharged to a bunker and from there be passed again to the conveyor leading to the furnace at such times as the blower supply is either short or off.

I strongly advise putting in the entire oven lining "headers" from the grates up, using "end-wedge" brick for the half-circle arch. Also, I have found that only the best quality firebrick will stand the heat that it is possible to obtain. For this reason the top of the furnace should extend under the front end of the boiler far enough to protect the first line of rivets. The Dutch-oven type of furnace is standard in the lumber industries of the north Pacific Coast, where mill refuse is the commonest fuel.

Vancouver, B. C., Canada. R. MANLY ORR.

Referring to the inquiry of Mr. McQuiddy in the May 8 issue, I have had considerable experience in this line and I consider the best method of generating power from refuse is by converting it into gas—preferably in a suction type of producer.

I have in mind a plant of 700-kw. capacity with an output of 25,000 kw.-hr. weekly (6 days). The fuel consumed consists of wood refuse, sawdust, shavings and bark, much of which is green and wet. The cost of generation, all expenses included, is 1.5c. per kw.-hr. Centrifugal extractors are employed to remove the tar and no trouble has been experienced with bad or dirty gas, the average CO content being 28.5 per cent. The engine's exhaust passes through a tubular boiler, and steam is generated at 50 lb. gage for wood drying, seasoning and pickling. Operation on producer gas has in my opinion many advantages and a full investigation always pays where there is much refuse of any kind to be dealt with. J. F. EDGETT.

Malden, Essex, England.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Diameter of Water Cylinders of Duplex Pump

Without allowance for piston rods or slippage what size of water cylinders would be required for a duplex pump to handle 6,000 gal. of water an hour if the stroke of the pump is 14 in. and there are 50 strokes a minute? J. C.

Pumpage of 6,000 gal. an hour, or 100 gal. a minute, would require a total piston displacement of $100 \times 231 = 23{,}100$ cu.in. a minute, and with a double-acting duplex pump, neglecting slippage and the reduction of the net piston area from presence of the piston rods, the displacement required per stroke of each piston would be $23{,}100 \div 50 = 462$ cu.in. If the length of stroke is 14 in., the area of each piston and cross-sectional area of each water cylinder would have to be $462 \div 14 = 33$ sq.in., which corresponds with a diameter of $\sqrt{33} \div 0.7854 = \sqrt{42.02} = 6.48$ in., or practically $6\frac{1}{2}$ in. in diameter.

Main Steam Outlets for Power Boilers

What determines the size of main steam outlets for power boilers? R. L. C.

The steam-pipe and safety-valve nozzles on a boiler usually are provided of the same size so they may be used for either purpose. The minimum size of main steam outlet usually is made to correspond with the largest size of steam-pipe connection likely to be selected with reference to the permissible drop in pressure. For power boilers the requirements generally are covered when the diameter of the main outlet in inches is equal to one-fortieth of the square root of the number of square feet of the boiler's heating surface.

The pipe sizes of nozzles usually provided are approximately as follows: Boilers having up to 400 sq.ft. of heating surface, 3-in. diameter nozzles; 400 to 850 sq.ft., 4-in. diameter; 850 to 1,500 sq.ft., 5-in. diameter; 1,500 to 2,000 sq.ft., 6-in. diameter; and for 2,000 to 3,500 sq.ft., 7-in. diameter. However, with the increasing use of higher steam pressures there is a tendency to provide smaller nozzles and steam pipes.

Synchronizing Alternating-Current Generators

We have two alternators with 30-in. pulleys driven by belt from 14-ft. flywheels. In synchronizing these machines, the throttle valve of the incoming machine is pinched down until it is just cracked, which causes the synchronoscope to revolve very slowly. This machine is cut in when the pointer of the synchronoscope is exactly vertical, but there is always a slippage of the belt on the incoming machine. This slipping is decidedly apparent each time the switch is closed, although, according to the synochronoscope the two machines are exactly in phase. The engines run at 105 r.p.m. and the drive is short. What causes the slipping of the belt? H. B.

Since the pointer on the synchronoscope remains in a vertical position after the switch is closed, the instrument must be connected correctly and the trouble is with the method of synchronizing the machines. There is always a time lag in closing the switch, so that if it were started closing at the instant the machines were in step, they would be going out of phase by the time the switch was closed. Therefore allowance should be made for this factor. The synchronoscope pointer should also be moving slowly in the fast direction so that if the switch is closed at the proper time, the machine will swing into step and begin picking up load. Just where is the best point to close the switch on the instrument can be determined only by trial. The first trial might be with the pointer moving slowly in the fast direction toward the mark and about $\frac{1}{4}$ in. away. If it is found that this reduces the slipping of the belt, try closing the switch with the pointer a little farther back. It will probably be found that the best position is somewhere between $\frac{1}{4}$ and $\frac{3}{4}$ in. back of the mark. In all cases the pointer must be moving slowly toward the mark in the fast direction. Do not close the switch after the pointer has passed the mark.

Relative Temperature and Pressure in Ammonia Compression

With the discharge pressure from an ammonia compressor of 170 lb. a thermometer in the discharge pipe close to the compressor shows a temperature of 180 to 190 deg. F. Is this about correct, and if not, what would cause the high temperature? C. D.

In most cases the ammonia enters the suction valve of a compressor in the form of a dry saturated gas or vapor, and work of compression increases both the pressure and temperature. There is very little gain or loss from the cylinder walls and the compression is practically adiabatic. The discharge temperature depends not only on the ratio of the discharge pressure to the suction pressure, but also upon the suction temperature. For instance, if the gas is received by the compressor at the temperature of 30 deg. below zero when it leaves the compressor, the temperature of the discharge will not be the same as if the gas had been received at a temperature of 32 deg. F., although the relation of the discharge to the suction pressure was the same in both instances. Hence it is impossible to state whether 190 deg. discharge temperature with 170 lb. gage pressure of the discharge is correct without knowing both the suction pressure and suction temperature.

By referring to the total heat diagram given on page 495, issue of Sept. 26, 1922, it may be seen that a dis-

charge temperature of 190 deg. F. and discharge pressure of 170 lb. gage (or 185 lb. absolute) corresponds with a suction pressure of 90 lb. gage. This is probably much higher than was obtained, and the suction pressure is probably about 20 lb. gage and the corresponding discharge pressure would be 135 lb. gage. The difference, 170 — 135 = 35 lb., would be pressure due to the presence of foreign gases in the ammonia. To have a discharge pressure of 135 lb. gage, the temperature at which the ammonia would condense would be 78 deg. F., calling for a cooling-water temperature of about 68 deg. F. In all probability the discharge temperature was correctly observed, but the discharge pressure that was obtained is too high and could be corrected by purging the system of foreign gases.

Setting Single Valve of Shaft-Governor Engine

What is the method of setting the valve of a single-valve shaft-governor engine? P C. L.

Shaft governors usually are keyed to the shaft and the position of the governor is fixed by the maker of the engine. However, if it is desired to find the position of the governor wheel with respect to the crank, first adjust the valve rod to such length that the opening edges of the valve travel the same distance beyond the opening edges of the ports when the governor wheel makes a complete revolution. Then place the engine on the head-end dead center and, with the governor weight blocked out to average load position, turn the governor wheel around to a position on the shaft where the head-end valve is just beginning to uncover the steam port of the head end; set the governor wheel fast in that position and turn the engine over to the crank-end dead center. If the valve on the crank end is not just beginning to uncover the port, correct one-half of the amount by adjustment of the valve rod, turn the engine over to the head-end dead center and set the governor on the shaft to a position that will give the valve about $\frac{1}{16}$ in. lead.

If the governor wheel is keyed to the shaft, the valve setting must be done solely by adjusting the length of the valve rod, by placing the engine on the head-end dead center, and then with the governor weights blocked out to the average load position, adjust the rod to give $\frac{1}{16}$ in. lead on the head end. But in any case the rod adjustment should be such as to give some lead on the crank end if there is any lead on the head end.

Velocity of Discharge Through Venturi Tube

How is the formula derived for velocity of water discharged through a venturi tube? R. G. H.

The energy of water flowing in a pipe consists of the head due to the velocity, the head due to the pressure, and the potential head or height above a datum plane as the surface of the tailrace of a waterwheel. If a constant quantity of water is flowing through a tube in a given time, the velocity varying at different points on account of changes in the diameter, the energy remains constant (loss by friction excepted) and the sum of the three heads is constant, the pressure head increasing as the velocity increases, and vice versa. This principle is known as "Bernoulli's Theorem."

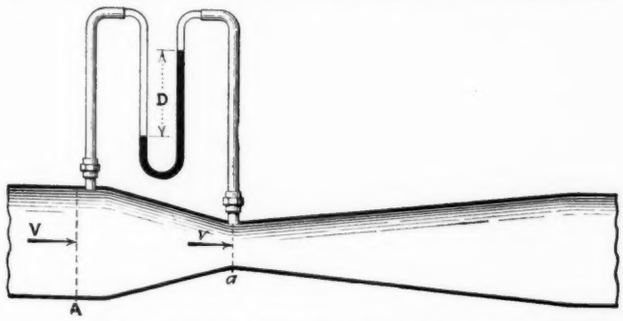
In the venturi tube shown in the illustration, calling A the cross-sectional area of the entrance section in square feet, V the velocity of water at the entrance section A in feet per second, a the cross-sectional area of the throat in square feet, v the velocity of water at the throat section a in feet per second, and g the acceleration of gravity = 32.16, then if H is the head corresponding to the velocity V and h is the head corresponding to the velocity v, $V^2 = 2gH$ and $v^2 = 2gh$, hence

$$v^2 - V^2 = 2gh - 2gH = 2g(h - H) \qquad (1)$$

The amount that the velocity head h at the section a is greater than the velocity head H at the section A is contributed out of the pressure head. Therefore, a differential pressure gage connected as shown would give this reduction of pressure, which, interpreted as feet of head, would make $D = h - H$ and (1) may be written

$$v^2 - V^2 = 2gD \qquad (2)$$

When D is measured in inches of mercury, the reading in inches is to be multiplied by 1.13 to obtain the



MEASUREMENT OF HEAD CONVERTED INTO INCREASE OF VELOCITY

equivalent value for D in feet of head. Since the same quantity of water passes the entrance section A as through the throat section a, $VA = va$, $V = \frac{va}{A}$ or $V^2 = \frac{v^2a^2}{A^2}$. Substituting this value of V^2 in (2) gives

$$v^2 - \frac{v^2a^2}{A^2} = 2gD \qquad (3)$$

$$v^2 = \frac{2gD}{1 - \frac{a^2}{A^2}} \text{ or } v = \sqrt{\frac{1}{1 - \frac{a^2}{A^2}}} \times \sqrt{2gD} \qquad (4)$$

This would be the theoretical velocity through the throat a without loss from friction. Calling the percentage of efficiency C, the formula becomes

$$v = C \sqrt{\frac{1}{1 - \frac{a^2}{A^2}}} \times \sqrt{2gD}$$

In carefully prepared venturi tubes, such as used in venturi meters, the constant C has a value of about 0.98.

Exclusion of Domes from H. R. T. Boilers

Why do some boiler rules preclude the use of steam domes on horizontal return-tubular boilers? R. L. B.

The opening for the dome through the shell and holes for the fastenings weaken the shell unless extraordinary precautions are taken in design and construction. Sometimes a heavy saddle ring is fitted to the outside of the boiler and the dome flange is riveted through it to the shell, but the strength of such a member is uncertain and many accidents have happened due to the removal of excessive amounts of the shell for such connections.

[Correspondents sending inquiries should give their full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

N. D. H. A. Holds Annual Convention at Cedar Point

From June 20 to 22 inclusive, the National District Heating Association held its fourteenth annual convention at Cedar Point, Ohio. Owing to its increase in membership, its improved financial condition from the increase in dues and the returns from the "Handbook," the society during the last year was in better position to do constructive work than ever before, and the results were reflected in the convention program, which contained a valuable collection of committee reports and addresses of practical value to the field. Registration showed an attendance of 121, representing over forty heating companies.

At the opening session President E. L. Wilder reviewed briefly the work of the year, which had been full of constructive effort. He referred to the appointment of a technical secretary to edit the *Bulletin* and favored a headquarters staff to organize the work of the various committees.

D. L. Gaskill, secretary-treasurer, reported a reduction in the debt of the association to a small item, with a sufficient amount due to create a substanial balance. The membership totaled 269. While the increase in dues had eliminated the deadwood, many new members had been added, so that in numbers, finances and conditions generally, the association was in a most favorable position.

Pipe-Corrosion Troubles Discussed

Time was still available at the first session for presentation, by W. J. Santmyer, of a paper reviewing the steam-heating system of Seattle, Wash. Two different plants supply the steam, one equipped with stokers and the other for burning powdered coal. A comparison of production costs given in percentages was interesting. Trouble had been experienced in vacuum heating systems from rapid corrosion in the horizontal sections of return lines. In the discussion of the paper turning to this point, it was pointed out that the pure water remaining in the horizontal run and the air in the system were responsible. Introducing certain mineral oils into the system had reduced the corrosion without harm to the boilers. Owing to the oil from the engines the corrosion was noticeably less in isolated plants.

In summarizing the subject of pipe corrosion, F. N. Speller, of the National Tube Co., stated that the fundamental causes were well established and might be classified into four groups—atmospheric corrosion, under-water corrosion, soil corrosion and electrolysis—with the corrosion from acid and alkaline solutions to be taken into account. The pipe user had fixed his mind first upon the materials, such as steel, wrought iron, etc., but it had been found that all corrode at about the same rate. Pipes had been improved as much as possible, the scale had been removed inside, and various alloys tried out. In the reduction of corrosion, more success was to be expected from treating the water. Taking the oxygen and noncondensible gases out of it would bring immediate results. The gases come into the system either through the makeup water entering the boiler or from leakage. Reducing both to a minimum is the cure for internal corrosion. In a vacuum system leakage at joints was prevalent, as it was necessary to depend upon lubricants of uncertain quality to keep the joints tight. A metallic lubricant of sufficient body to give the desired results had now been perfected.

As trouble from corrosion had been greatly on the increase, a standing committee was appointed to make a thorough investigation.

C. F. Hirshfeld, chief of the research department of the Detroit Edison Co., discussed recent power-plant developments. He was not enthusiastic over the recent trend toward excessive pressures and temperatures. Before adopting blindly European practice or following certain leaders in this country, it would be well to consider the increased cost and see if the added economy is justified. The load factor would have a decided bearing. Two new cycles have been adopted and a kilowatt-hour on one pound of coal, or 14,000 B.t.u., is in sight. This can be done, but the increase in cost has not been studied sufficiently. In the boiler room, burning powdered coal had certain advantages, but stoker development was not over. There were still possibilities from preheated air and furnace volumes larger than had been allotted to the stoker in the past. This talk in fuller detail will appear in an early issue.

Station Operating Committee Reports

In the report of the Station Operating Committee, presented by R. D. DeWolf, chairman, a variety of interesting subjects were discussed. Attention was called to the possibilities of powdered coal for new and existing plants. The powdered-coal installation of the Rochester Gas & Electric Corporation was described. This plant differs from others in that it has no separate building for fuel preparation, no conveyors for the pulverized fuel and no driers. Ordinarily, Pennsylvania coal containing 4 to 6 per cent moisture is burned. A large number of small openings in the front and side walls admit the secondary air, and the lower furnace walls are cooled by the combustion air.

As an addendum to this portion of the report, J. C. Hobbs presented the results of a nine months' test on Stirling boilers of the Duquesne Light Co., equipped to burn powdered coal. During this period not a boiler was taken off the line for repairs, and the results generally were so favorable that larger boilers at Bruno's Island are being similarly equipped.

Another feature of the report were the results from a series of tests to determine the effectiveness of soot blowers and the proper intervals between blowing. A report was made on an installation of Tracy steam purifiers in the drums of two boilers in the Rochester plant. The purpose was to eliminate the moisture in the steam, amounting to ½ of 1 per cent, before it passed to the superheater; otherwise the soluble salts carried over with this small amount of moisture would be liberated as dry solid particles in the superheater and give trouble by lodging in pipe lines and valves. In general the results obtained were satisfactory and additional boilers are to be equipped.

The advantage of installing superheaters in stations doing purely a steam business was brought out in the report. Comparative tests on a given line indicated a material reduction in heat loss provided the steam was superheated before being delivered to the distribution system. The B.t.u. loss per hour per square foot per degree difference in temperature with superheated steam was only about 60 per cent of the loss for saturated steam, and with the latter there was the additional loss from trapping out the condensation.

Discussion of Report

Discussion on the report turned to the temperature at which the steam should be turned into the main, the possible destruction of the insulation and the relative advantages of superheated steam to the producer and the consumer. Theoretically, the superheat should be sufficient to take care of the radiation loss in the line and deliver saturated steam to the consumer. The capacity of the line would be increased as all of the steam would reach the customer and none condense. With customers at varying distances it might be found necessary to desuperheat the steam so as to maintain a constant temperature at a certain point in the distributing system.

Last year the Heating Research Committee presented a number of charts showing the variation in steam and electric demands for various classes of buildings. The method of charting was unusual and the results misinterpreted so that a second presentation in different form, with additional data, was made this year. As expressed by H. T. Luscomb, chairman, the purpose of the report was to present a plan for estimating the extent of exhaust steam utilization, where the complete information necessary for individual calculation was lacking. Briefly, the report showed how the low-pressure steam demands may be expected to vary from hour to hour, and to compare this with the exhaust steam available for corresponding hours. In different types of buildings the hourly usage of both steam and electricity will differ, so that charts were prepared on

different classes of structure; such as office buildings, hotels and clubs, theaters, recreation buildings, stores and residences.

During the year the Heat Utilization Committee had been particularly busy and in the report presented by O. W. Kastens were valuable data on the following subjects: Maximum demand, return temperatures, water and direct-air heating economizers, economy of the vacuum system of heating, and thermostatic vs. manual control of steam, with a concluding outline listing the various sources of waste. As a part of the report J. E. Seiter described a steam demand meter adaptable to condensation meters in which a certain change of parts converted the operation from electrical to mechanical action, this being desirable, as electric service is not always available.

In the discussion reference was made to the practice of storing heat in a building at night and shutting off the steam during the peak to help even up the demand. In certain buildings where the control valve was located in the station, this was being done in St. Louis with a saving to the customer, although generally it was the consensus of opinion that such procedure would result in a loss to the consumer unless he was given a concession in rates.

On regulation J. C. Butler presented a chart with curves on four buildings, two with hand control and short-hour heating, one with thermostatic control and short-hour heating and the fourth with thermostatic control and long-hour heating. With the hand control the hourly rate was more nearly constant for the season and higher than for thermostatic control owing to the automatic shutting off of steam in the latter system as the temperature increased. Long-hour heating showed the lowest rate per hour, but in the total steam for the year, the short-hour heating had the advantage. Other discussion dealt with water and air economizers and the flexibility of the vacuum system of heating, with a preference expressed for the location of vacuum pumps in the various buildings of a group, over a central vacuum. Wet pressure return lines were favored.

New Steam-Heating Plant Having a Number of Progressive Features

H. F. Eddy, of the Consumers Power Co., outlined the salient features of a new steam-heating plant for the City of Grand Rapids. The design incorporates a number of progressive features. High-pressure boilers operated at 350-lb. pressure and from 400 to 450 per cent of rating will generate the steam, and it is estimated noncondensing turbines will recover sufficient byproduct power to pay for the fuel. Steam will be extracted for feed-water and furnace air preheated. Feed water will be softened and purified, a special draft system is to be used and economizers operating as low-pressure waste-heat boilers will steam into the heating main. A description of this plant will appear in an early issue.

In the report of the Hot-Water Heating Committee an outline was given of experimental work undertaken to develop a reliable and noiseless customer's meter. Mention was made also of a new type of meter that had been brought out in Toledo. It consisted of a pitot rod attached to the main at any desirable point. The readings served to check up the loss from the main. Measuring the water going into a district checked on the connected load and readily showed wastage or insufficient service.

In the round table on new appliances, an established feature of the convention, descriptions were given of the new Hyperbo-Electric steam-flow meter, the "Univent" or unit system of ventilation originated by the Herman Nelson Corp., of Moline, and the new corrugated copper expansion joint of E. S. Badger & Sons Co. It is made in diameters from 2½ to 20 in. to take care of an expansion of 2 in. and for any pressure up to 200 lb.

In the report of the Distribution Committee results of investigations made during the past season in Detroit on transmission loss and a novel method of tunnel ventilation were presented by N. W. Calvert. The report included an interesting paper by Charles O. B. Murphy on "Balancing the Load," prepared from the viewpoint of the sales department.

Officers elected for the coming year were: F. B. Orr, president; C. H. Day, first vice-president; O. W. Kastens, second vice-president; G. W. Martin, third vice-president; H. A. Woodworth and Charles O. B. Murphy, executive committee.

Electrical Engineers Discuss High-Pressure Steam Plants

During the week of June 25 to 29 the American Institute of Electrical Engineers held its thirty-ninth annual convention at Swampscott, Mass., with headquarters at the New Ocean House. About 1,200 members and guests registered. The convention was formally opened with the first technical session Tuesday morning. After Dr. A. E. Kennelly presented greetings to the members and their guests, President Frank B. Jewett delivered his address, "The National Engineering Societies, Their Problems of the Past, Present and Future." He said in part:

In viewing the varied activities of our national engineering societies and the problems which now confront them, one cannot help being struck by the fact that the tremendous changes of the past decade, which have so altered our whole economic, social and political life, have brought a multitude of new problems to the engineering societies; that it will require the utmost of clear thinking on the part of our members and officers, if these problems are to be solved in a manner befitting the profession of which we are a part.

In those matters of concern where the questions are broader than the interests of any particular group of engineers, where our own interests as engineers call for common action, and where the public at large and our legislators and executives have a right to expect an opinion from us as engineers, it seems clear that the efforts of the last few years in this direction must be carried forward as expeditiously as possible and a satisfactory mechanism found. Differences of opinion as to method, and difficulties which arise out of various schemes or organization and qualifications for membership in the engineering societies, must not be allowed to stand in the way of our early ultimate success. So much publicity has been given to the organization of engineers along this line and so much has been said of the benefits to be derived from this organization that any substantial failure to achieve the results which the public has been led to expect would be forthcoming, would, I think, lead to a state of affairs so disastrous to the engineering profession and to the public welfare that we dare not contemplate it.

Whatever, therefore, may be our individual opinions with regard to the composition or conduct of the Federated American Engineering Societies, which is our existing mechanism in this field, I am certain equally that a method must and can be found for making this organization, by evolutionary rather than revolutionary processes, all that we believe such an organization should be.

As to those interests of the national engineering societies, in the National Research Council and in the proper conduct of the trust which we have undertaken in the creation of Engineering Foundation, there is little further which need here be said. Our difficulties of the moment arise more from not having a simple, concise, thoroughly understood and agreed to picture of aim and objective than from any fundamental diversity of opinion. Until this objective is achieved and the case is set forward in a way which cannot be misunderstood, until we have organized the administration of our interests satisfactorily in conformity with the objective sought, and until we have established that close association between this administrative machinery and the governing bodies of the founder societies without which lasting success and healthy development is impossible, it is futile and worse than futile to consider the details of intricate organization or plans for great expansion. The problem is ours and can be solved if we but set ourselves the task. It requires a critical clear-sighted analysis of the objective desired and of the methods needed to reach this objective, combined with a courage to put our conclusions into effect. When we succeed in doing this, we will have built upon the groundwork already laid, the foundations of a structure which will last through the ages, which will grow with time and which will be of immeasurable benefit, not alone to us of the engineering societies, but to all who are in any way affected by our works.

At the Wednesday morning meeting the paper about

which most interest centered was "Some Engineering Features of the Weymouth Station of the Edison Electric Illuminating Company of Boston," by I. E. Moultrop and Joseph Pope, which was presented by Mr. Pope. This plant is expected to have an ultimate capacity of 300,000 kw. The present construction covers the installation of two 32,000-kw. generating units with three 19,740-sq.ft. boilers, operating at 375 lb. steam pressure and 700 deg. F. In addition, a single boiler to carry steam at pressures up to 1,200 lb. is to be installed. This boiler will have about the same heating surface as the normal-pressure boilers. The steam generated by it will pass through a pressure-reducing turbine developing about 2,000 kw., and will be exhausted at 375 lb. pressure. After being reheated to the original temperature of 700 deg. the steam will be piped to the main header and used in the large turbines. If satisfactory results are obtained from the higher-pressure boiler-turbine units, more of them will be installed. Three will be required to furnish sufficient steam to operate one of the 32,000-kw. units.

The maximum steam temperature was fixed at 700 deg. in consideration of the properties of materials at the higher temperatures. While the theoretical gain from higher pressure increases up to the maximum for which any data are available, the full benefit of the thermodynamic possibilities are not at present obtainable in practice without reheating the steam at some point intermediate between the throttle and the condenser. Without reheating, the most advantageous steam pressure, both practically and economically considered, seems to be about 375 lb. gage. With reheating, it appears that about 1,200 lb. is a practicable initial pressure, and that 375 lb. is an entirely satisfactory pressure at which to reheat. Accordingly a combination of these two pressures with intermediate reheating has been adopted; the higher pressure with a view to developing its possibilities, the lower pressure with the feeling that it represents the best practice in the single-expansion cycle and that operation solely at that pressure will give highly economical results. The character of the future development of the plant will depend on the relative performance of the two classes of equipment. A comprehensive abstract of this paper will be in the next issue.

Discussion on Weymouth Power Station

Mr. Moultrop, in discussing the plant, pointed out that up to a year or two ago large steam-power stations had become fairly well standardized and that almost over night the state of the art had changed. Of the new stations now under construction or projected practically each represents a new departure in plant design. A careful study has shown that there is little difference in the economy of stoker or powdered-coal fired boilers. In Boston on account of the long distance from the mines it is necessary to use the best grades of coal obtainable and in this case stokers had an advantage over powdered coal. However, the speaker expressed the opinion that there were many places where powdered coal was the proper thing. He believed that high-pressure steam had a lot of merit and that the 1,200-lb. proposition promised a higher efficiency than 550 lb. with reheating. Mr. Moultrop said that a kilowatt-hour on 15,000 B.t.u. had been predicted and he believed that in the near future this was going to be accomplished and that Weymouth was going to make it uneconomical to bring St. Lawrence power to Boston for many years to come.

S. Z. de Ferranti submitted a written discussion in which he expressed the opinion that the design of Weymouth station was correct in its essentials. He questioned the use of economizers and expressed a preference for air preheaters, and suggested that the distance between the reheater and turbine should be short.

Dr. D. S. Jacobus said that in developing the boiler for 1,200 lb. working pressure his company had before it the results secured with the use of 1-in. tubes in a great number of its marine boilers built for torpedo-boat service and the results of the experiments on boilers without steam and water drums using 2-in. and 1-in. tubes, also the results secured with a drumless B.&W. boiler built for test purposes a number of years ago where there was water storage, the drum being replaced by a number of horizontal tubes connected to headers. A great number of different arrangements were laid out and considered, and the one finally adopted closely approached a standard boiler. A power-plant boiler under the present conditions of service must be arranged so that it can be thoroughly cleaned both inside and out. The use of 2-in. tubes, such as will be supplied for the boiler, gives a convenient size for internal cleaning, whereas it is difficult, if not impossible, to clean tubes properly, say, of 1-in. diameter and smaller. Were it possible to maintain at all times absolutely tight surface condensers, it would be unnecessary to clean the interior of the boiler tubes, the art of boiler design would be considerably simplified, and smaller-diameter tubes could be used provided they were arranged so that they could be thoroughly cleaned on the outside.

Peter Junkersfeld called attention to the importance of load factor on the design of power stations and that we are no longer operating power plants but systems. In this scheme the station that shows the lowest cost of operation per kilowatt output is given the best load factor, but five years hence the designs of power plants may have improved so that a plant that had been operated as a base-load station will be superseded by a new station. The speaker was favorably impressed with the present trends in power-plant design.

Harvey N. Davis said that steam pressures had reached such value where the present steam tables are no longer good and a number of men were endeavoring to revise them. He reported that the part of the work assigned to Harvard University had been completed up to 750 lb. and he would like to know where the university could secure an automobile boiler for higher pressures. When this is secured, they are ready with the apparatus for pressures up to 1,200 pounds.

L. L. Elden outlined the proposed 110,000-volt ring transmission system around the district supplied by the Edison Electric Illuminating Co. This system, it was explained would be favorable for the introduction of hydro-electric power from the St. Lawrence and interconnecting with the proposed superpower system for the Northeast Atlantic seaboard, and at the same time meet the power needs for trunk line railway electrification of Boston.

H. P. Liversidge pointed out that the design of power plant involves the problem of producing power not only at the highest efficiency, but also at the lowest cost. Although radical departures had been made in power-plant design, he believed them to be along sound engineering lines. In the design of power stations it is not a case of the engineer's doing what he might wish to do in the way of efficiency, but he must be careful not to put himself in a position where he can be criticized regarding the economy of the plant.

H. W. Hales said that except for the high-pressure portion of the Weymouth Station the same principles had been carried out in the design of the Cahokia Plant at St. Louis, where powdered coal is to be burned. He was of the opinion that much of the discussion on the new power stations was of a conjectural nature, and he was going to wait until after operating data were available on these plants before making a decision for or against high steam pressure.

In closing the discussion, Mr. Moultrop pointed out that there was nothing about Weymouth station that was experimental except the 1,200-lb. part, which was so small as to be of secondary consideration in so far as the plant as a whole was concerned. Even if this part of the plant should be found to be unworkable, the only part that would have to be scrapped was the high-pressure turbine, which is of special design. The pressure of the 1,200-lb. boiler could be reduced to the normal pressure of the station and used as the standard boiler. The electric generator is also of standard design. However, there is little doubt about the ultimate success of the 1,200-lb. installation. Troubles are to be expected as in any new development, but these will be of a nature that can be solved and when they have been new 1,200-lb. units will be added to the station as the load factor of the system warrants. Mr. Moultrop made a strong appeal for greater activity in research work. It was his opinion that in this respect we were falling down in this country and if we are going to continue to lead the world research work must be greatly stimulated.

News in the Field of Power

New York State Owned Water Power Not Under Federal Control

Decided in Conference Between the Attorney-General's Office and Federal Government

CONSIDERABLE progress to overcome the legal difficulties which have so far thwarted development of the state-owned water power in New York has been made as the result of a conference between the Attorney-General's office and the federal government, as a result whereof it seems entirely likely that litigation to determine the state's rights under the Esch law will not be had.

The federal government, upon presentation to it of the contentions of New York State and upon examination of its water-power law, has receded entirely from the position that it would exercise supervision over water-power development of canalized inland streams and has expressed a willingness to co-operate with the state in its plans by statute for the development of water power either by private lease or by the state itself.

This means that the United States government has withdrawn its support from the program of Governor Pinchot of Pennsylvania, in which he sought to establish the position of primary federal supremacy in regulation of the development of all water power, under the superpower development plan, and that applications now pending with the New York State Water Power Commission may be approved and development maintained, and that the state itself may by appropriation of money or by bond issue, undertake a comprehensive system of development of state-owned power.

This does not mean, however, that the state will abandon its suits pending against some 80 owners of mostly undeveloped private water-power rights and riparian rights in the St. Lawrence River watershed, which actions have been brought with the idea of securing to the state the sovereignty over all of the units of the St. Lawrence power essential to its successful development either by the state itself or through private capital.

The history of these particular power and riparian rights dates back to chapter 280 of the Laws of 1826 of New York State, which reads in part:

Be it enacted by the State of New York, represented in Senate and Assembly, That David A. Ogden, of the county of St. Lawrence, being the proprietor of both sides of a branch of the River St. Lawrence, in the town of Madrid, and across which river he has erected a dam and locks, in pursuance of an act of the legislature of this state, passed 1st April, 1808, shall and he is hereby declared to be vested with all the rights of the people of this state to the lands situate below the said dam, and which by reason thereof has been rendered susceptible of improvement, and extending down the branch of said river, from the said dam, to the navigable waters thereof, to have and to hold to the said David A. Ogden, his heirs and assigns forever. . . .

The state, therefore, is seeking to determine through legal adjudication just what it owns within its boundaries and what it may use or lease.

Of course the sensible solution to the problem would be a special act of the legislature taking possession of the dam on the south channel of the St. Lawrence river and such power and riparian rights as are needed and allow the various parties aggrieved to come into the court of claims for compensation.

The Ferris amendment to the New York State Constitution allowing the building of transmission lines and power stations on the lands of the forest preserve goes to the people for approval at the general election in November. So far the press has paid little attention to this important matter. Its failure of ratification will mean that the St. Lawrence power, if developed, cannot be economically transmitted to the Capital district and New York City, because under the constitution as it now stands, transmission lines cannot be built through the forest preserve in the Adirondacks.

The New York State Water Power Commission is preparing a report based on the negotiations had by the state agencies with the Federal authorities which wil be submitted to Governor Smith within the next two weeks. The report will outline suggestions for immediate steps to be taken to secure power development in this state. Were the present legislature receptive to a policy of state development of power, a special session of that body would undoubtedly be called to enact such legislation as would enable the state to take stragetic advantage of the situation and to insure to it the inception of a definite policy, but with the Republican Assembly committed to a policy of private development and unwilling to yield even to a policy which would permit the state *and* private capital to develop and transmit power, such course seems entirely unlikely.

The people unfortunately understand but little about the water-power situation. Certain special interests bent on individual spoilation have prevented for a period of 30 years the promulgation of any plan of state development. On the other hand, the state in its various attempts at hydro-electric development has presented legislation which represented the last word in radicalism, containing a mixture of state development and municipal ownership, calculated to arouse both the opposition of vested capital and the suspicion of the people as to the ultimate good to be accomplished.

Unaflow Engine Pumping Plant To Be Installed

The Metropolitan District Commission of Massachusetts has let a contract for the machinery for the Ward Street, Boston, sewerage pumping plant. The contract calls for the installation of a 35,000 gal. per min. Morris Machine Works centrifugal pump, having a 36-in. discharge and a 42-in. suction.

This pump will be direct-connected to a 530-hp. Norberg unaflow steam engine having a 24-in. diameter by 40-in. stroke cylinder and will operate at 150 r.p.m. The guaranteed duty is 103,000,000 ft.-lb. per 1,000 lb. of steam when operating with dry saturated steam at 150-lb. gage pressure and with a condenser pressure of 4 in. of mercury. The pump efficiency will be approximately 80 per cent, which with a 95.3 per cent mechanical efficiency of the engine, calls for a Rankine efficiency of 70 per cent in order to fulfill the guarantee.

Course for Oxy-Acetylene Welders Outlined

The American Welding Society has just issued an outline of a course for the training of oxy-acetylene welders. This outline is the result of a report that was prepared by a committee, and combines the experiences of experts of the Federal Board of Vocational Education, the American Welding Society and the National Research Council. For the information of the person who is selecting candidates, the text includes a discussion of the qualifications which the candidate for training should possess; for the information of the instructor, the text includes the fundamentals in gas welding, together with a detailed statement of content, classified under type welding jobs arranged in the order of difficulty. Copies may be secured from the American Welding Society, 29 West 39th St., New York.

S. P. E. E. Discusses Qualifications of the Engineer

OVER three hundred engineering educators were in attendance at the annual convention of the Society for the Promotion of Engineering Education, held in Ithaca June 20-22. The major topic for discussion was training engineers for leadership in industry and public service.

At the opening session Dean Dexter S. Kimball presented a notable address on this topic. He stated that twenty years ago the idea of a course for leadership training was startling, but that now this topic was of major interest and importance. Up to the introduction of electrical engineering, engineers were designers, builders and operators, but the technical requirements governed the manufacture of electrical apparatus so greatly that engineers were forced to enter into the shops as managers and foremen. Also this type of development occurred in sales engineering where, at present, technical engineers are essential to advise about and sell equipment. The business world, according to Dean Kimball, now desires and admires the engineering way of doing things and in so far as design, operation and management of industry are concerned, the engineer will reign supreme in a short time. Any changes that are made in engineering education must not occur in a way that will undermine the fundamental training that has produced the engineering type of mind. If the fundamentals of science, mathematics, chemistry and physics are neglected in training for leadership, failure will ensue. However, the intelligent leader must understand mass production, finance, management and human relations.

On Thursday morning T. H. MacDonald, chief of the Bureau of Public Roads, Washington, D. C., gave a paper on the "Engineer as a Leader in Public Service." He stated that the public does not rapidly impose authority on any class or group of people, but waits for demonstrations of competency. Measurement of the amount of engineering leadership is best found by studying the degree of authority they now exercise. And in spite of the difficulty of breaking through tradition and precedent founded on national habits of thought, study shows that the engineer has proved his value as a leader in public service. The accomplishments of engineers have changed the conception of government and modified the ways heretofore used to support human existence.

The engineer as a leader in industry was the subject of a notable paper by O. S. Lyford, of the National Industrial Conference Board. He stated that engineers should be leaders because they have a method of attack and a scientific mind and industry counts as fundamental the underlying scientific training of the engineers. Three questions are presented: (1) Does industry need more or fewer engineers than now available? (2) What kind of education should they have? (3) What is the responsibility of the industry in their work?

There is a lack of adjustment between the schools and the industry. About 5 per cent of the total positions open in manufacturing are leadership positions for which men are needed. This amounts to 750,000 men out of about 13 million men. Of this 750,000 men 4.5 per cent are owners, managers and executives in small establishments, while in factories employing over 1,000 men there are only about 1,000 chief executive positions, or 20.03 per cent.

It is important to stimulate and educate men having a natural talent to become leaders. There is an annual demand for men for these positions, many times exceeding the supply put out by the colleges. But there are no concerted efforts made or proper methods in vogue for getting the right men into the right places and consequently there is great waste. Of all the males between 30 and 50 years of age 96 per cent are gainfully occupied in this country, and the percentage occupied by the 70,000 college men is very small—57,000 compared to 33 million. We now have 129 engineers schools with 53,000 enrolled, they form an essential part of industry, and industry is showing a growing tendency to select and use these men. A study of graduates who have been out of Rensselaer, Harvard, Lehigh and Stevens for 5, 10, 20 and 25 years shows a decided shift from engineering work to other work as years elapse. Some of the shift is due to failure, but most is due to a logical change in occupation and shift to position of leadership and responsibility. Experience shows, however, that a good technical expert seldom develops into a good executive but he possesses qualities that are essential to a good executive.

E. M. Herr and F. B. Jewett are typical of industrialists who state that schools should devote their efforts to teaching fundamentals and not attempt executive training.

W. E. Wickenden spoke on "The Engineer in Business" and read a committee report which stated that a broader equipment must be possessed by engineering teaching staffs and that economic and physical analyses should be a larger element in the pedagogical process. The broad viewpoint of engineering must be the engineering and economic adaptation of science for industrial and social well being. He took the Bell system as a typical example of an organization for studying the engineer in business. The Bell system consists of an operating company, affiliated companies for furnishing equipment and the general staff of executives, legal aids, etc. The study included only the first and third departments.

In six representative telephone companies a study was made of the type of responsibility and form of service. The technical responsibility decreases as the upper grades are reached; legal increases and administrative is about the same. Many of the men in the administrative groups in the upper grades had engineering training. Analysis shows that the college man has an increasing share of executive responsibility as years of service elapse while the non-college man's share decreases. The analysis shows that the biggest executives of college-graduate class reach their positions in five years' less time than the non-college graduate type who attains the same executive position. Eighty-nine per cent of the college graduates exceed the average progress rate of the non-college man. Eleven per cent of the non-college men exceed the progress rate of the college graduates. In the whole chief executive staff of the Bell system 39 per cent were engineering graduates and 32 per cent other college graduates. The engineers have largely been instrumental in the development of the Bell system, but have not stood out as the business executives.

Niagara Power Interests Desire More Water

While the Governments of Canada and of the United States are maneuvering so as to secure maximum advantage in any reallocation of the diversion from the Niagara River, the power interests are advocating a temporary agreement whereby each side may use water up to the installed capacity of existing plants pending the ratification of a new treaty.

It is recognized that the making of a treaty under the existing conditions must be a long drawn out process.

The situation in western New York and in Ontario are such that there is an imminent need for more power. It is an established fact that the manufacturing growth of western New York must be curtailed within the next few months if additional power cannot be secured. The situation is almost as bad in Ontario.

An important influence on the whole situation will be exerted by the completion of the development of the Niagara Falls Power Co., which will leave an installed capacity of 115,000 hp. lying idle while water far in excess of scenic requirements is tumbling over the falls. This will come at a time when the industrial progress of a populous area will have been very noticeably curtailed.

The matter will be accentuated in Canada when the three new units of the Ontario Hydraulic Commission are installed. It will require 6,000 cu.ft. per sec. more than is granted by the treaty to operate them.

Since the treaty may have to include such highly controverted matters as the drainage diversion at Chicago, the diversion at the Welland Canal and

through the New York Barge Canal, it is apparent to all on each side of the river that a temporary agreement must be set up.

The main thing making for delay is the determination of the United States government to secure a greater proportion of the diversion. Under the existing treaty Canada gets 36,000 cu.ft. per sec., while the United States gets but 20,000. Canada naturally is maneuvering to hold the advantage she now enjoys.

Increased Coal Production

Bituminous coal production in May totaled 46,035,000 tons, as against 42,564,000 tons in April. Anthracite production amounted to 8,573,000 tons, compared with 8,063,000 tons in April, according to *Commerce Reports*.

Engineer Corps and N. E. L. A. to Make Power Survey

As a measure of preparedness the Corps of Engineers of the Army, in co-operation with the National Electric Light Association, is making a survey to determine the most prompt and the cheapest steps that can be taken to increase on short notice, the amount of electrical power that can be made available in critical areas.

During the World War there was a shortage of power in most of the vital centers. It is hoped plans can be worked out that will permit more efficient use of power resources should another emergency arise and provide means whereby expansion can be put into effect quickly. The plan also involves the working out of a centralization of authority to undertake allocation of power to essential industries.

The F. A. E. S. to Participate in World's Power Conference

The Executive Board of the Federated American Engineering Societies voted to participate in the World's Power Conference which will be held in London in 1924. The Board also voted to authorize President Mortimer E. Cooley to appoint representatives to attend this conference.

I. C. C. Makes Two Decisions Affecting Coal Transportation

The Interstate Commerce Commission made, on June 26, two important decisions which will be an undeniable bearing on the coal situation.

An order forbidding the railroads after Sept. 1 to allot any extra cars to soft-coal mines whose product is intended for railroad fuel or to give preference in car supply to mines that own their own cars and the denying of the application of the Virginian Railway to build a new spur of coal road on the ground that the company did not now furnish enough cars to transport the coal already offered to it, should prove beneficial in solving some of the coal troubles.

Hoover Makes Suggestions to the Railway Fuel Associations

Three important suggestions were made by Secretary Hoover in a letter to the president of the International Railway Fuel Association, as follows: That the railroads co-operate more closely with producers in matters affecting coal, that the association's activities in matters concerning coal storage be continued, especially along economic lines with reference to costs, investments charges and the general economic value of storage, and that more attention be paid, in the future, to greater uses of lower grade coal, of which there are enormous reserves; that the railroads follow the recommendations of the railway executives and store the coal used for railroad purposes before the first of September.

President Harding Stresses the Importance of Coal Commission Report

Attorney-General Daugherty Also Sends the Commission a Letter

TWO letters of unusual importance were recently received by the United States Coal Commission. One was from the President urging the importance of an agreement being reached in the anthracite field. The other was from the Attorney General pointing out that it would be in violation of our statutes if the alleged agreement exists whereby British coal diggers would not mine coal for shipment to the United States during a strike here and whereby the American union would conduct itself similarly during a strike in the British Isles.

It is very apparent that the Commission made no mistake in the appraisal of the value of the two propositions. The daily press attached great news value to the Attorney General's letter, but gave only incidental attention to the letter of President Harding. The President's letter undoubtedly was prompted by the election of Rinaldo Capellini to the presidency of District No. 1 of the United Mine Workers of America. This victory for the radicals among the workers in the anthracite region reaffirms the presence of a unrest among them, which had its first outbreak in the demand for nationalization. The Coal Commission is even in a better position to know its important portent. That is why its members apparently attached so much importance to the letter from the White House and seemingly dismissed the letter from the Department of Justice with the statement that they have no information as to such a contract. Chairman Hammond stated positively that John L. Lewis, on appearing before the Commission after his return from Europe, gave no intimation of having negotiated any such agreement.

The full text of the President's letter, which was addressed to Chairman Hammond, is as follows:

In acknowledging your brief statement of the progress of the work of the Coal Commission, I wish to express again the high value I put upon the work you are doing. Though this is the season of the year when both temperature and vacation habits may tempt the average citizen to dismiss the subject of coal, the issue remains a serious one, and I, therefore, bespeak for the forthcoming report of your Commission on the anthracite industry a most thoughtful reception. No solution of this vexing, economic question can be found except as the general public thoroughly digests the facts you present and decides upon the proper action to take.

I regret that those who serve the anthracite-consuming public as mine operators and mine workers, have not already agreed upon the terms of a new contract, but with your report available on July 1, there should be no delay in reaching a speedy agreement. The public deserves prompt assurance that there will be no interruption after Aug. 31 in the flow of household coal from mine to market.

As I believe your Commission stated in an earlier report—industry and the home alike must be freed from the menace of constant interruption of their coal supply. To that end public opinion must be a well-informed public opinion, and I, therefore, trust that our citizens may keep up a lively interest in coal in season and out of season. The subject is a most interesting one, but it is much more; the issue is a vital one in that it affects the well-being of the whole Nation, and not in a material way alone, for I know questions are before you that strike deep into the very heart of our American institutions.

The full text of Attorney General Daugherty's letter, also addressed to Mr. Hammond, is as follows:

My attention has been called by publication and otherwise, to what is claimed to be a contract entered into or proposed to be entered into between certain officials of the United Mine Workers of America and others in this country with certain officials of a similar organization and others in foreign countries, represented to provide and to agree that in event a strike should be declared or in force in this country in the mining interest—no coal would be mined for shipment to this country by miners belonging to said organizations in such foreign countries, during the period of a strike that might be in force in this country.

I can hardly conceive that any person in this country would enter into such a contract, for I am satisfied that such a contract would be a violation of our laws. If coal were required for transportation purposes for use in Interstate commerce in this country, any such interference with the supply of coal will be prevented by the Government of the United States promptly and forcefully.

I shall be glad to be promptly advised as to the facts in possession of or obtainable by your Commission in order that such action may be taken as is justifiable.

American Committee of World Power Conference Organized

Delegates from various national, professional, technical, business and commercial societies, including representatives from the federal government, met in New York City on June 20 to effectuate a plan of organization of the American Committee of the World Power Conference to be held in London in 1924, drawn up by a subcommittee of which John W. Lieb was chairman.

The following officers were elected: Executive chairman, O. C. Merrill, Federal Power Commission; first vice-chairman, H. J. Pierce, president Washington Irrigation & Development Co., representing the American Electro-Chemical Society and the National Electric Light Association; William M. Steuart, Director of the Bureau of Census; Peter Jungerfeld, consulting engineer, N. Y., representing the American Society of Civil Engineers; Calvin Rice, Secretary of the American Society of Mechanical Engineers; David P. Rushmore, General Electric Co., representing the American Electro-Chemical Society, the American Institute of Mining and Metallurgy Engineers, the American Society of Mechanical Engineers; Calvert Townley, Westinghouse Electric & Mfg. Co., representing the Federated American Engineering Societies, the American Institute of Electrical Engineers; H. M. Addinsell, of Harris, Forbes & Co., N. Y.; H. I. Harriman, president New England Power Co., representing the U. S. Chamber of Commerce; Fred R. Low, editor of *Power*, representing the American Society of Mechanical Engineers and the Federated American Engineering Societies; John W. Lieb, N. Y. Edison Co., representing the American Institute of Electrical Engineers, and the Association of Edison Illuminating Companies.

Two Units Installed at Great Falls

Two units of the Manitoba Power Co. at Great Falls are in operation, according to the *Canadian Engineer*. The work is not entirely completed so that they are not operating under a full head of water; but the construction will be finished this summer, about four to six months ahead of the original schedule. The present installation calls for 56,000-hp. with an ultimate capacity of 168,000.

Personal Mention

R. G. Cushing, formerly electrical engineer with the Winchester Repeating Arms Co., New Haven, is now engineer in the electrical division of Stone & Webster, Inc., Boston, Mass.

H. O. Murphy, formerly maintenance engineer for the Consolidated Stone Co., and the Ingalls Stone Co., of Bedford, Ind., is now engineer in the electrical division of Stone & Webster, Inc., Boston, Mass.

Calvin L. Jones, welding engineer of the Westinghouse Electric & Manufacturing Co., Atlanta, Ga., has been elected vice-president of the American Welding Society. Mr. Jones has been elected for a two-year term and will be in charge of the activities of the society in the Southern Division.

George A. Stetson, assistant professor of mechanical engineering at Yale University, and for the last four years editor of the "Transactions of The American Society of Mechanical Engineers," has resigned both these positions to enter the wholesale coal business in Boston.

Coming Conventions

American Institute of Electrical Engineers, F. L. Hutchinson, 29 West 39th St., New York City. Pacific Coast Convention at Del Monte, Calif., Oct. 2-5.

American Institute of Mining and Metallurgical Engineers; F. F. Sharpless, 29 West 39th St., New York City. Annual meeting at Ontario, Quebec, Canada, Aug. 20-31.

American Society of Civil Engineers; J. H. Dunlap, 33 West 39th St., New York City. Annual Convention at Chicago, July 11-13.

Association of Iron & Steel Electrical Engineers; J. F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Iron and Steel Exposition at Buffalo, N. Y., Sept. 24-28.

American Society of Refrigerating Engineers, William H. Ross, 35 Warren St., New York City. Nineteenth Annual Convention at New York City, Dec. 3-5.

International Union of Steam and Operating Engineers; Dave Evans, 6334, Yale Ave., Chicago, Ill. Annual convention at Detroit, Sept. 10-15.

National Association of Practical Refrigerating Engineers; Ed. H. Fox, 914-25 East Jackson Blvd., Chicago. Fourteenth Annual Convention at Memphis, Dec. 12-16.

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Buffalo, N. Y., Sept. 10-15. Annual conventions and exhibitions of the State Associations scheduled as follows: **Michigan** at Flint, July 18-20, E. C. Smith, 308 Vine St., Kalamazoo, Mich. **New England States Association**, at Manchester, N. H., Manchester Hotel, July 12-14; Freeman L. Tyler, 32 Briggs St., Taunton, Mass. **Pennsylvania**, at Buffalo, Sept. 9-10; J. N. Calvert, Crafton Sta., Pittsburgh, Pa. **New York**, at Buffalo, Sept. 9-10; W. T. Meinzer, Third St., near Warburton, Bayside, L. I., N. Y. **Minnesota**, at Duluth, Aug. 8-10; C. A. Nelson, 800 22d Ave. N. E., Minneapolis.

National Safety Council, W. H. Cameron, 168 North Michigan Ave., Chicago, Ill. Twelfth annual congress at the New Statler Hotel, Buffalo, N. Y., Oct. 1-5.

New England Association of Commercial Engineers; James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show at Mechanics Bldg., Boston, Mass., Oct. 29-Nov. 3.

The New England Water Works Association; Frank J. Gifford, 715 Tremont Temple, Boston, Mass. Annual Convention at Burlington, Vermont, Sept. 18-21.

National Exposition of Power and Mechanical Engineering; Charles F. Roth, Room 1102, Grand Central Palace, New York City. Power Show, Dec. 3-8.

Ohio Electric Light Association, D. L. Gaskill, Greenville, Ohio. Annual convention at Cedar Point, Ohio, July 10-13.

Society of Naval Architects and Marine Engineers, Daniel H. Cox, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 8-9.

Universal Craftsman Council of Engineers; John F. Amos, P. O. Box 299, Rochester, N. Y. Convention at Rochester, N. Y., Aug. 7-11.

Obituary

Louis Bell, consulting electrical engineer and authority on power transmission and optics, died at his home in West Newton, Mass., June 14. Dr. Bell was born on Dec. 5, 1864, in Chester, N. H. He graduated from Dartmouth College in 1884 and received his degree of Ph.D. from Johns Hopkins University in 1888. In 1890 he became editor of *Electrical World* and retained this post for two years only, but remained a contributing editor up to the time of his death. His book. "Electric Power Transmission" (1897), was an authority on the subject for years and was translated into French and German. He lectured at the Massachusetts Institute of Technology on Power Transmission and at Harvard University on public lighting, and about forty patents relating to power transmission and optics were taken out by him. He was a member of the A.I.E.E. and past president of the Illuminating Engineering Society.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	June 18, 1923	June 25, 1923
Pool 1,	New York	$3.50@4.00	$3.50@4.00
Smokeless,	Columbus	3.75@4.10	3.50@3.75
Clearfield,	Boston	2.00@2.75	2.00@2.75
Somerset,	Boston	2.50@3.00	2.25@3.00
Kanawha,	Columbus	1.90@2.20	1.75@2.00
Hocking,	Columbus	1.75@2.10	1.75@2.00
Pittsburgh No. 8	Cleveland	1.85@2.00	1.85@1.95
Franklin, Ill.	Chicago	3.00@3.25	3.00@3.25
Central, Ill.	Chicago	2.00@2.25	2.00@2.25
Ind. 4th Vein,	Chicago	2.50@2.75	2.50@2.75
West Ky.,	Louisville	1.65@1.85	1.65@1.85
S. E. Ky.,	Louisville	2.00@2.25	2.00@2.25
Big Seam,	Birmingham	1.85@2.25	1.85@2.25

FUEL OIL

New York—June 28, Port Arthur light oil, 22@25 deg. Baumé, 5⅜c. per gal.; 30@35 deg., 5¾c. per gal., f.o.b. Bayonne, N. J.

Chicago—June 23, 24@26 deg. Baumé, $1.97 per bbl.; 32@36 deg., $2.27 per bbl., tank cars.

St. Louis—June 19, tank-car lots, f.o.b. St. Louis: 24@26 deg., $1.80 per bbl.; 26@28 deg., $1.85 per bbl.; 28@30 deg., $1.90 per bbl.; 32@36 deg., gas oil, $2.20 per bbl.; 36@40 deg., distillate, $2.35 per bbl.

Pittsburgh—June 19, f.o.b. local refinery, 30@34 deg., fuel oil, 4⅞c. per gal.; 36@40 deg., fuel oil, 5¼c. per gal.; 34 deg., neutral, 8½c. per gal.

Dallas—June 22, f.o.b. local refinery, 26@30 deg., $1.51 per bbl.

New Plant Construction

PROPOSED WORK

Ala., Greenville—The mayor and city council will soon award the contract for the construction of a modern oil burning municipal lighting plant. Two units of 50 and 100 hp. each will be installed as soon as the buildings are completed; later on other units will be installed.

Calif., Anaheim—J. Siegel, 921 North Los Angeles St., representing building association, plans to build a 5 story hotel on Broadway. Cost will exceed $250,000.

Calif., Long Beach—I. Butterfield, 800 Pacific Ave., is having plans prepared for the construction of a 12 story apartment house on Linden Ave. Cost will exceed $500,000. Davies & Baume, Marine Bank Bldg., Long Beach, Associated Archts. Equipment detail not reported.

Calif., Los Angeles—A. C. Blumenthal, Loew State Bldg., plans to build a 12 story apartment building on Hollywood Blvd. Estimated cost $1,000,000.

Calif., Los Angeles — A San Francisco syndicate is having plans prepared for the construction of a 10 story apartment hotel on Wilshire Blvd., here. Estimated cost $850,000. Walker & Eisen, Pacific Finance Bldg., Los Angeles, Archts. Equipment detail not reported.

Calif., San Francisco—A. J. Fabre and E. Hildebrand, Archts., 110 Sutter St., are preparing sketches for the construction of a 6 story hotel and store building, to contain 175 rooms, 8 stores, in the downtown section of the city. Estimated cost $300,000. Owner's name withheld.

Calif., San Francisco — Kincanon & Perego, 159 Sutter St., is having plans prepared for the construction of a 5 story apartment house to contain 32 3, 4 and 5-room apartments on Washington and Franklin Sts. Estimated cost $500,000. C. W. Mahoney, 892 Union St., San Francisco, Archt. Equipment detail not reported.

Calif., San Francisco—The Office of United States Engineer, 85 2nd St., will receive bids until July 6 for 1,000 hp. electric motor for booster pump.

Calif., San Francisco—Two Thousand and Six Washington St., Inc., c/o C. A. Meussdorffer, Archt., Humboldt Bank Bldg., is having plans prepared for the construction of a 7 story apartment building (second unit) on Washington St. near Gough St. Estimated cost $1,500,000. Equipment detail not reported.

Fla., De Land—The Bd. of Trustees will receive bids until July 17 for the construction of waterworks improvements, etc., including sewers, water mains, three pumps, two pump houses, one generator unit and accessories J. B. McCrary Eng. Corp., 3rd Natl. Bank Bldg., Atlanta, Ga., Engrs.

Fla., Miami—The Ponce de Leon Co., c/o F. V. Newell, Archt., is having plans prepared for the construction of a 9 story, 85 x 110 ft. hotel at 227 Flagler St. Estimated cost $500,000.

Fla., Miami—Tatum Bros., 214 12th St., are having plans prepared for the construction of a 10 story, 60 x 152 ft. store and office building on East Flagler St. and 2nd Ave. Estimated cost $500,000. Kiehnel & Elliott, Miami, Archts. Equipment detail not reported.

Ga., Atlanta—The Atlanta Realty, Hurt Bldg., is having plans prepared for the construction of a 17 story, 90 x 166 ft. office building on Ivy St. Estimated cost $900,000. H. Tallant, 70 East 45th St., New York, Archt. Equipment detail not reported.

Ga., Savannah—The Office of the United States Engineer received bids for two 15 in. dredge pumps from J. Rourke & Sons, Bay St., Savannah, $2,270; Merrill-Stevens Shipbuilding Co., 612 East Bay St., Jacksonville, Fla., $2,850; Ellicott Machine Corp., Bush and Severn Sts., Baltimore, Md., $2,698. Noted June 5.

Ill., Chicago—D. S. Klafter, Archt., 64 West Randolph St., is preparing plans for the construction of a 2 story, 150 x 310 ft. store, office, theater and apartment building, including steam heating system, on Fullerton and Crawford Sts. Estimated cost $750,000. Owner's name withheld.

Ill., Chicago—H. Minkus, c/o Leichenko & Esser, Archts., 38 South Dearborn St., is having plans prepared for the construction of a 12 story, 194 x 302 x 500 ft. apartment hotel, including steam heating system, on Albion, North Shore and Lake Michigan Sts. Estimated cost $3,000,000.

Ind., Indianapolis — The Mchy. Clearing House, 424 Bd. of Trade, is in the market for an 8,000 to 10,000 hp. boiler.

Ind., Kendallville—The McCray Refrigerating Co. is having plans prepared for the construction of a 1 story, 75 x 220 ft. addition to its plant. Estimated cost $50,000. A. M. Strauss, 701 Schoaff Bldg., Fort Wayne, Archt.

Ia., Shenandoah—The city plans an election to vote on $175,000 bonds for the construction of an electric light and power plant. R. L. Keltner, Shenandoah, Engr.

Ky., Ivel—The Camp Branch Coal Corp., S. R. Jennings, Purch. Agt., is in the market for equipment to partially electrify coal mine.

Ky., Louisville—The Doric Apartment Co. is having plans prepared for the construction of an 8 story, 150 x 200 ft. addition to the Willow Terrace apartments, including elevators, on Willow Ave. Estimated cost $750,000. Joseph & Joseph, Francis Bldg., Louisville, Archts.

Ky., Murray—The City Council, c/o M. T. Morris, is in the market for a 200 hp. oil engine with auxiliary equipment.

Minn., St. Paul—The city will hold an election July 16 to vote bonds for the construction of waterworks improvements as follows: Vadnais Lake conduit, $870,898; Pleasant and Sucker Lake conduit and canal, $90,000; Centerville conduit, $61,000; large feeder mains in city, $598,300; distribution mains, meter, etc., $850,000. G. M. Shepard, City Engr.

Mass., Somerville—The Fresh Pond Ice Co., 321 Washington St., is having preliminary plans prepared for the construction of an ice manufacturing and storage plant. Cost between $50,000 and $60,000. Private plans. Ice manufacturing machinery, handling equipment and conveyors, etc., electrically operated, will be installed. Separate contracts for construction and machinery.

Mo., Holden—The city defeated $75,000 bonds for the construction of waterworks improvements. A new election will be called soon. Noted June 12.

Mo., Kansas City—W. E. Gilham, Mech. Engr., 409 Interstate Bldg., will receive bids about July 24 for heating and ventilation system in 4 story, 140 x 160 ft. office building for the Kansas City Life Insurance Co., Rialto Bldg. Estimated cost $30,000. Wight & Wight, 1st Natl Bank Bldg., Kansas City, Archts. Noted June 26.

Mo., Kansas City—C. A. Smith, Archt., 601 Finance Bldg., is receiving bids and will open same about Aug. 15 for the construction of a 4 story, 150 x 290 ft high school on 48th and Poseo Sts. for the Bd. Educ. Estimated cost $1,400,000. Equipment detail not reported. Noted Nov. 7, 1922.

Mo., St. Louis—The Amalgamated Assn. of Street & Electric Employees, No. 788, 4036 Chouteau Ave., has purchased site and plans to build a 10 story or more, 148 x 158 ft. office building to contain halls, large auditorium, etc., on Grand Blvd. Estimated cost $1,000,000. Engineer or architect not announced.

Mo., St. Louis—F. L. Cornwall, La Salle Bldg., is having plans prepared for the construction of a 164 x 219 ft. apartment hotel on Kingshighway. Estimated cost $1,000,000. W. S. Frank, Century Bldg., St. Louis, Archt. Equipment detail not reported.

Mo., St. Louis—A local syndicate has purchased site and is having plans prepared for the construction of a 10 story, 77 x 100 ft. office building on Grand Blvd. Estimated cost $500,000. L. B. Pendleton, 119 North 7th St., St. Louis, Archt. Equipment detail not reported.

Mo., St. Louis—The Stix, Baer & Fuller Co., 6th and Washington Sts., plans to build an 8 story, 105 x 160 ft. department store on Lucas Ave. Estimated cost $2,000,000. Engineer or architect not announced.

Mo., Stockton—G. B. Seward is having plans prepared and will soon receive bids for the construction of a hydro-electric plant and spillway, 130 ft. long, 10 ft. high on the Sac River; 18 mile transmission line from here to Fair Play. Estimated cost $50,000. Russell & Axon, 404 McDaniels Bldg., Springfield, Engrs. The engineers are in the market for two 2,300 volt, 60 cycle generators; two 36 in. vertical reaction turbines.

Nev., Reno—The Riverside Hotel Co., H. L. Stevens & Co., promotors, 433 California St., San Francisco, Calif., plans to build a 6 story hotel, to contain 210 rooms, here. Estimated cost $700,000.

N. J., Trenton—The Masonic Home Assn. is having plans prepared for the construction of a masonic home on West Front St. Estimated cost $500,000. H. A. Hill, Broad St. Bank, Trenton, Archt. Equipment detail not reported.

N. J., Verona (Montclair P. O.)—The Essex Mountain Sanitarium will receive bids until July 6 for the construction of a boiler house. Estimated cost $150,000. Gailbert & Bettelle, 2 Lombardy St., Newark, Engrs. and Archts.

N. Y., Brooklyn—The New York Telephone Co., 15 Dey St., New York, is having plans prepared for the construction of a 3 story, 200 x 213 ft. telephone exchange on Rockaway Ave. near Riverdale Aves., here. Estimated cost $700,000. McKenzie, Voorhies & Gmelin, 342 Madison Ave., New York. Engrs. and Archts. Equipment detail not reported.

N. Y., New York—E. Margolies, 19 East 33rd St., had plans prepared for the construction of a 12 story, 110 x 125 ft. apartment house at 3-11 West 47th St. E. De Rosa, 110 West 40th St., New York, Engr. and Archt. Equipment detail not reported.

N. Y., New York—The Octo Building Corp., c/o Rouse & Goldstone, Archts., 512 Fifth Ave., is having plans prepared for the construction of a 14 story, 100 x 136 ft. apartment building at Bway. and 88th St. Estimated cost $1,500,000. Equipment detail not reported.

Ohio, Dayton—The Miami Valley Hospital, Apple St., is having plans prepared for the construction of a 5 story, 80 x 200 ft. hospital. Estimated cost $500,000. Schenk & Williams, Mutual Home Bldg., Dayton, Archts. Equipment detail not reported. Noted Apr. 3.

Ohio, Lima—The Ohio Power Co., Newark, plans to build a high tension substation which will carry unlimited current from its plant at Fostoria and Lima. Estimated cost $100,000.

Ohio, Steubenville—The Tri State Amusement Co. is having plans prepared for the construction of a 2 story, 150 x 180 ft. theatre on 4th and Adams Sts. Estimated cost $500,000. C. H. Crane, 542 Griswold St., Detroit, Mich., Archt. Equipment detail not reported.

Pa., Farrell — Roccapalumba & Marine, 615 Idaho St., are in the market for mechanical refrigeration equipment for wholesale fruit and produce plant at 602 Idaho St.

Pa., Grantville—The Grantville Electric Co., H. C. Stambaugh, Mgr., plans to build an electric light and power plant. Estimated cost $50,000. The owner is in the market for machinery and equipment.

Pa., Huntingdon—The Boyle Ice Co. is in the market for ice manufacturing machinery and refrigeration equipment for $85,000 plant.

Pa., New Castle—The Consumers' Ice Co. is in the market for ice manufacturing machinery and refrigeration equipment for proposed large plant.

Pa., Pittsburgh — The Allegheny County Steam Heating Co., 703 Chamber of Commerce Bldg., C. W. Lepper, Purch. Agt, is in the market for coal unloading and conveying machinery for new plant on Duquesne Way.

S. D., Castlewood—The city is having plans prepared for the construction of a waterworks system, including mains, pump equipment, etc. Estimated cost $18,000. Chenoweth, Kennedy & Rettinghouse, Boyce-Greeley Bldg., Sioux Falls, Engrs.

S. D., Lemmon—The city, R. M. Watson, Auditor, will receive bids until July 16 for the construction of waterworks improvements, including c.i. pipe, hydrants, pump, deep well and 34 x 35 ft. standpipe. Estimated cost $25,000. C. L. Pillsbury Co., 1200 2nd Ave., S., Minneapolis, Minn., Engrs.

Tenn., Lenoir City—The Tennessee Electric Power Co., Hamilton Natl. Bank Bldg., Chattanooga, has purchased plant, here, and will provide for additional service, line extensions, transformers, etc. Estimated cost $25,000.

Tenn., Memphis—The Southern Hotel Co., Inc., 257 South Main St., is having plans prepared for the construction of a 12 story, 200 x 342 ft. hotel and store building on Union, South 2nd and 3rd Sts. Estimated cost $4,250,000. W. W. Ahschlanger, Inc., 65 East Huron St., Chicago, Archts. Equipment detail not reported.

Tenn., Nashville—The Bd. of Trustees of Vanderbilt University, J. H. Kirkland, Chancellor, will receive bids until July 16 for the construction of a 337 x 458 ft. medical hospital and laboratory, also nurses' home, power plant and laundry on the Vanderbilt Campus. Estimated cost $2,000,000. Coolidge & Shattuck, 122 Ames Bldg., Boston, Mass., Archts. Equipment detail not reported.

Tenn., Trezevant—The city, J. J. Blanks, Mayor, voted $35,000 bonds for the construction of a municipal light and power plant.

Tex., Galveston—The city, J. H. Kelly, Secy., will soon receive bids for rebuilding Alta Loma pumping plant and extensions as follows (1) furnishing and installing 2 oil engine driven generator sets, $40,000; (2) 21,000,000 gal. wells, $24,000; (3) flow lines from well to plant, $14,000; (4) motor driven air compressor, $10,000; (5) 3 motor driven pumps, 3,000,000 gal. capacity each, $6,000; (6) 24 in. pipe line from Galveston pumping plant to stand pipe, $3,000; (7) steam pumps at Galveston plant, 6,000,000 gal. capacity, 25,000. Noted June 5.

Tex., Houston—F. A. Shaffer, c/o Guardian Trust Co., Main and Franklin Sts., is having plans prepared for the construction of a 20 story Medical Arts building on Main St. Estimated cost $1,500,000. Crane & Franzhelm, Chronicle Bldg., Houston, Archts. Equipment detail not reported.

Tex., Hubbard—The city, J. C. Mecklin, Mayor, holds an election July 3 to vote on $55,000 bonds for the construction of a waterworks system, including mains, pumps, etc.

Tex., Sanger—The city, A. Boydson, Mayor, will hold an election July 10 to vote $55,000 bonds for complete waterworks system, $22,000 for sewerage system and $17,500 for electric light plant. Dawson Eng. Co., Insurance Bldg., Dallas, Engrs.

Tex., Throckmorton — The city is having surveys made and will soon hold an election to vote on $40,000 bonds for the construction of a reservoir, earth dam, concrete spillway, elevated tank and tower. Baker & Von Zuben, Ellison Bldg., Fort Worth, Engrs.

Wash., Port Angeles—The Lilliwaup Land & Resort Co. plans the development of a tourist resort, including power plant, generating capacity 4,000 hp.; 600 room hotel, etc., on Hoods Canal. Estimated cost $1,000,000.

W. Va., Beachbottom—The Amer. Gas & Electric Co. plans to rebuild the portion of its power plant which was destroyed by fire. Estimated cost $50,000.

W. Va., Buckhannon—The Great Lakes Coal Corp. is in the market for coal handling machinery and equipment for station at Erie.

W. Va., Charleston—The Virginia Power Co is in the market for a belt conveyor and other equipment for power house extension.

W. Va., Killarney—The Killarney Smokeless Coal Co. is in the market for electric coal mining machinery and equipment, including transmission and conveying machinery.

Wis., Evansville—H. F. Brunsell is in the market for coal handling machinery, cranes, hoists and conveyors for coal storage elevators.

Wis., Madison—The State Bd. of Control, Capitol Bldg., F. Crocker, Secy., is in the market for refrigeration equipment for morgue at Wisconsin State Hospital; power plant equipment, motors, belting and shafting for power plant alterations at the State Prison, Waupum.

Wis., Manitowoc—The Manitowoc Cement Co., 16th and River Sts., C. C. West, Pres., is in the market for kiln equipment, coolers, turbines, several large motors, about 400 hp., also small motors for cement mill. Noted Jan. 19.

Wis., Sheboygan — J. Herziger, 1326 Superior Ave., is in the market for ice machine and refrigeration equipment for proposed sausage factory.

Wis., Wisconsin Rapids—The Bd. Educ., c/o Clerk, City Hall, is having plans prepared for the installation of a new steam heating plant in Lincoln High School, including two low pressure boilers. Estimated cost $25,000.

Ont., Bancroft—The Bancroft Light, Heat & Power Co. is having plans prepared for the development of 2,500 hp., about 50 ft. head, equipment to include turbines, generators, oil switches, circuit breakers, lightning arresters, insulators, panels, cranes, gates, racks, etc., at High Falls on the Madewaska River. Estimated cost $300,000. Private plans.

Ont., Hastings—W. G. Plant is in the market for a 56 in. Lefee waterwheel.

Ont., Kenora—J. T. McLellan, Mgr., is in the market for complete electric light and power plant machinery, boilers and equipment.

Ont., Kirkland Lake—The town, M. Campbell, Clk., plans the installation of a waterworks system, including mains, pumps, hydrants, valves, pumphouse, also reservoir or tank. Estimated cost $150,000. Engineer or architect not selected.

Ont., Niagara Falls—The Dominion Power & Transmission Co., Terminal Sta., Hamilton, has purchased additional power from the Canadian Niagara Power Co., to supplement its own supply from Decew Falls and plans to install machinery and equipment for changing 25 cycle current to 60 cycle, here.

Ont., Schumacher—The McIntyre Porcupine Mines, plan to sink their main shaft to a depth of 5,000 ft. and to increase their milling capacity by erecting a new mill on another section of their mine. Hoisting equipment, crushers, tube and ball mills, pumps, electric motors and cyanide apparatus will be required.

Ont., Timmins — The Hollinger Consolidated Gold Mine plans to purchase and install a Diesel oil engine to develop about 12,000 kva., also a 9,00 cu.ft. per minute air compressor. A. F. Brigham, Mgr..

Ont., Toronto—The Home for Incurables, Bloor St., is having plans prepared for the construction of a 2 or 3 story addition to its hospital. Estimated cost $300,000. E. J. Lennox, 362 Bay St., Toronto, Archt. Equipment detail not reported.

Ont., Toronto—The Manufacturers Life Ins. Co., Dominion Bank Bldg., is having plans prepared for the construction of a 8 or 10 story office building, including elevators, electric lighting, etc., on Bloor St. Estimated cost $1,000,000. Sproatt & Ralph, 36 North St., Toronto, Archt. Noted May 8.

Que., Montreal — The Canadian Paperboard Co., Seigneurs St., will have plans prepared for the installation of about 800 hp., partly water turbines on Lachine Canal and balance steam driven electric generators, including low head turbines, steam boilers and stokers. Estimated cost $200,000. Kerry & Chace, Confederation Life Bldg., Toronto, Ont., Engrs.

CONTRACTS AWARDED

Calif., San Francisco—The Bd. of Park Comrs. awarded the contract for furnishing and installing sea water pumping equipment for municipal swimming pool, consisting of 16 in. centrifugal pump, total lift 32 ft., 700 g.p.m. capacity, direct connected to horizontal motor to the Price Pump & Engine Co., 33 Stevenson St., San Francisco. Noted June 17.

Ill., Chicago — The Chicago Tribune, Michigan and Austin Sts., awarded the contract for the construction of a 20 story, 100 x 300 ft. office building to R. Wiebold & Co., 1534 West Van Buren St. Estimated cost $7,000,000. Steam heating system will be installed.

Ia., Dubuque—The city awarded the contract for the construction of two pumping stations to J. A. Gregory, 1120 Iowa St., Dubuque, $29,477 and $11,187; drilling artesian well to C. W. Varner, 1695 Washington St., Dubuque, $9,417. Mead & Seastone, Engrs., Journal Bldg., Madison, will soon receive bids for equipment. Noted May 15.

La., Lecompte—The Mayor and Bd. of Aldermen awarded the contract for one 100 hp. and one 50 hp. oil engine directly connected to alternators; panel switchboard; motor driven domestic service pump; motors; air compressor to Fairbanks, Morse & Co., 608-14 Niagara St., $23,475; concrete reservoir, building, etc., to the Hayden Constr. Co., Pass Christian, Miss., $12,750; water well to the Gray Artesian Co., Amer. Natl. Bank Bldg., Pensacola, Fla., $4,000. Noted May 22.

Mich., Detroit—The Dept. Public Wks. awarded the contract for the construction of a 52 x 130 ft. sewage pumping station, 40 ft. well and pumping equipment consisting of two 24 in. two 15 in. and one 12 in. electrically operated centrifugal pumps, to the Natl. Constr. Co., 1031 Dime Bank Bldg., Detroit. Estimated cost $177,700. Provision will be made for additional pumping units as needed.

Mich., Detroit — The Public Lighting Comn., Atwater St., E., awarded the contract for four 20,000 kw. turbo units for power plant on Morrell St., to the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. $1,254,000. Noted May 29.

Minn., St. Paul—The St. Paul Gas Light Co., 6th and Cedar Sts., awarded the contract for the construction of a 150 x 60 ft. pulverizing building, a power house and a 2,500 kva. steam turbo electric power plant, on island in Mississippi River, to Siems, Helmers & Schaffner, 514 Guardian Life Bldg. This corrects report in Mar. 20 issue.

N. Y., New York—The Broadway & 40th St. Corp., 130 West 42nd St., I. Roth, Pres., awarded the contract for the construction of a 24 story, 65 x 200 ft. office building on 40th St. and Broadway to S. S. Roth & Bros., 54 Davis Bldg., Dayton. Estimated $5,000,000. Equipment detail not reported.

N. Y., New York—The New York Telephone Co., 15 Dey St., awarded the contract for the construction of a 30 story telephone exchange building on West, Barclay, Washington and Vesey Sts. to M. Eidlitz & Son, Inc., 41 East 42nd St. Estimated cost $11,250,000. Equipment detail not reported. Noted Apr. 17.

N. Y., Olean—The Vacuum Oil Co., 926 Exchange St., Rochester, awarded the contract for the construction of the first unit of large addition, consisting of a central boiler and steam plant for Nos. 1 and 2 parts of its refinery, here, to the Havens Constr. Co., Olean. Estimated cost $93,000.

Ohio—Cleveland—The city awarded the contract for two 1,400 hp. boilers with superheaters to the D. Connolly Boiler Co., Ivanhoe Rd., Cleveland. Estimated cost $84,528.

Ohio, Cleveland—The Cleveland Electric Illuminating Co., Illuminating Bldg., E. G. Crawford, Secy., awarded the contract for the construction of a 3 story, 108 x 194 ft. substation on East 70th St. and Lake Erie to J. Gill & Sons, Citizens Bldg., Cleveland. Estimated cost $750,000. Noted May 15.

Ohio, Troy—The city awarded the contract for the construction of a low concrete municipal dam in the Miami River to Price Bros., 54 Davis Bldg., Dayton. Estimated cost $59,000.

Ore., Astoria—The Astoria Central Heating Co., F. B. Nye, Secy., will build by day labor a central heating plant. Estimated cost $102,000. F. J. Dorsey, Vancouver, B. C., Engr.

Tex., Denton—The Bd. of Regents, College of Industrial Arts, awarded the contract for mechanical equipment for steam distribution system to Tenison Bros., Elm St., Dallas, $46,526; concrete tunnels to M. B. Whitlock, Denton, $47,517.45. Noted Mar. 27.

Wis., Columbus—The Chrisholm Scott Vines Co., awarded the contract for the construction of a 2 story, 50 x 100 ft. factory, including 40 ft. smokestack and boiler room, to Haserfus & Ibisch, Columbus. Estimated cost $50,000. High pressure boilers and piping for boiler room will be required.

Wis., Madison—The Hotel Wisconsin Realty Co., 86 Michigan St., Milwaukee, awarded the contract for the construction of a 10 story, 132 x 144 ft. hotel on West Washington St., to the S. M. Siesel Co., 160 Ogden Ave., Milwaukee. Estimated cost $1,000,000. M. Tullgren & Sons Co., Archts., 425 East Water St., Milwaukee, will receive bids until July 5, for the heating mechanical ventilation, plumbing and electrical work. Noted June 5.

Wis., Oconto—The Oconto Lumber Co. awarded the contract for the construction of a 40 x 80 ft. power house and a 60 x 150 ft. dry kiln to J. Young & Bros. and to J. Derks. Estimated cost $60,000. Power boilers and dry kiln apparatus will be required.

Wis., Oshkosh—The Water Dept., A. C. McHenry, Mayor, awarded the contract for pumping machinery for waterworks plant to the Langstadt-Meyer Electric Co., 14 Waugoo St., Oshkosh. Estimated cost $31,738. Noted June 5.

Wis., Reeseville—The village, A. C Buss, Clk., awarded the contract for the construction of a 50,000 gal. steel tank to the Chicago Bridge & Iron Wks., 608 South Dearborn St., Chicago, $6,500; 250 g.p.m. centrifugal pump and two electric motors to the Dayton-Dowd Co., 30 North Michigan St., Chicago; drilling 12 in. well to E. C. Schaefer, Beaver Dam. Noted May 29.